UNIVERSITÀ DEGLI STUDI DI MILANO

PhD Course in Science of Sport and Physical Exercise

Department of Biomedical Science for Health

UP150 PROACTIVE OFFICE: THE OFFICE THAT EDUCATES ON EMPLOYEE CARE AND WELL-BEING THROUGH PHYSICAL EXERCISE FOR HEALTH

M-EDF/02

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General Introduction.

1. Prolegomena

Any learning (intended as a stable behavior modification) is based on specific theories and develops through active involvement in meaningful actions and interactions considering the historical and social context. For these reasons, the present study's structure is based on social theories contextualized in the working environment to introduce a new company vision. In this vision, the working environment is intended not only as a place for productivity but also as a care and educative environment for the employees, as they spend most of their lives in it. There is no intention to underestimate productivity and efficiency as a part of the working context. In this specific environment, the reach of pre-determined goals and final results are determinant. The intent is to demonstrate with scientific and experimental experience how the traditional paradigm, stating that "physical exercise intended as a recreative moment is opposed to useful and effortful work and represents a waste of time", is no longer actual. The main idea is to insert physical exercise into usual workflow to help employees increase their motivation to exercise and the amount of physical activity they do daily, consequently improving not only their health and wellness (physical literacy) but also their working productivity.

2. Literature's general background

These ambitious purposes started from an emergent need of modern industrialized society. Indeed, it is a common belief that workplaces (specifically office-like rooms) are the leading cause of sedentarism or stress, which negatively impacts desk-worker employees. It is essential to consider that employees spend about half of their day in the workplace (Holtermann et al. 2021), and most common jobs require sedentary activities for a prolonged time, increasing the time spent sitting. From this point of view, it could be difficult for the employees to reach the recommended 150–300 min of moderate physical activities or the 75–150 min of intense physical activities (Bull et al. 2020).
The scientific literature evidence that physical inactivity can already represent a risk factor for public health (Blair 2009; Zelle et al. 2017). Considering the costs of this risk factor, the World Health Organization reported that the sanitary costs of each country attributable to physical activity range from 1% to 3% (World Health Organization 2018). This is not surprising if we think that, recent data highlight that 36.8% of people living in higher-income countries are not active enough (Guthold et al. 2008).
The problems associated with physical inactivity have been exacerbated during the SARS-CoV-2 pandemic, when research has shown a significant increase in sedentary behaviors and a decrease of active lifestyles and moderate activities of population (Ammar et al. 2020). Furthermore, the pandemic brought new challenges not only bound to physical activity but also for work-life balance. Indeed, to solve companies' organizational issues due to lockdown, new strategies were boosted. Hence, the work-from-home modality was broadly experienced worldwide, and it has nowadays become a new form of remote work named "hybrid work" which combines an on-site job in the usual workplace with a remote job, generally at home (Williamson, Colley, and UNSW Canberra and CQUniversity 2022). Nevertheless, even if this working modality is positively integrated into our society and solves the leading companies' organizational problems, hybrid work does not seem to have changed the employees' psychological discomfort and inactivity (Becker et al. 2022; Wells et al. 2023). One suggested solution to increasing workers' wellness is to promote physical activity and healthy lifestyles in the companies welfare, given the elevated percentages of occupational diseases (70%) represented by non-communicable diseases caused by unhealthy behaviors (World Health Organization 2010). The Global Action Plan on Physical Activity 2018–2030 (World Health

Organization 2018), identifies the workplace (both on-site and remote working modality) as key to promoting a physical activity culture, by introducing active pauses, salutary physical activity, and active urban mobility. Possible advantages caused by this type of intervention are the increase in employees' wellness, productivity and soft skills (developing social relations and problem-solving capacities), reduced absenteeism, and costs for public health (Grimani, Aboagye, and Kwak 2019; McEachan et al. 2011). In the same global action plan, it is highlighted that workplace intervention must be focused on creating active environments, modifying the architectural structures of the workplace, and creating active people, intervening in the employees' lifestyle (World Health Organization 2018).

Nowadays, the most common types of worksite physical activity interventions include: i) incorporating specific workout areas (company's gym) located inside the workplace to be used off working hours; ii) providing incentives for off-site fitness centers to attend after work; iii) offering interventions by specialists at the workplace before work, during lunch breaks, after work, or at home. (Robroek et al. 2009). Nevertheless, qualitative research on workers reported that each of these interventions aimed at promoting physical activity could have some barriers to overcome: amount of workers' spare time (outside of working hours), life scheduling (fitting into work/life balance), fatigue from long working days (too tired at the end of the day to engage in physical activity), and motivation (inadequate perception of the ability to engage in physical activity; Fletcher, Behrens, and Domina 2008b). Hence, the office concept UP150 has been designed to address the aforementioned issues emerging from working reality. It relies on environmental modifications, technological implementation, and support from movement specialists (sport science graduates) to educate employees on healthy routines and habits to follow during usual workflow (Invernizzi et al. 2022). This form of employee education aims to reduce sedentary behaviors at the workplace and to promote and disseminate physical literacy among desk workers as part of a lifestyle change process.

The principle underlying this new office concept is the education of employees starting from the workplace and how the workday could be approached. Targeting workers at various levels (multi-level approach) makes it possible to personalize the experience, motivate, and permanently educate them (Achor 2012; Deci et al. 1989; Goldberger and SueSee 2020; Von Korff et al. 1992). This multi-level intervention is needed because, tools and technologies to encourage physical activity in the workplace are not enough to change ingrained sedentary habits, as they are less likely to be maintaining in the long term (Bardus, Blake, Lloyd, and Suggs 2014).

Hence, we introduced four main elements whose interaction can efficiently impact the workplace: the Cubo Fitness Test, the modification of the working environment, the pocket trainer, and the wellness coaches. The Cubo Fitness Test is a submaximal set of tests based on effort perception that aims to analyze the employee's general physical fitness and set weekly goals based on test results (Invernizzi et al. 2022). The working environment modifications allow the insertion of new physical activity possibilities during the usual workflow and facilitate the approach to daily movement (Invernizzi et al. 2022). The "pocket trainer", proposed to employees through a dedicated digital app, allows them to interact with the working environment modification, set weekly goals of physical activity, and enhance consciousness of self, using perceived exertion scales to monitor the physical exercise. Furthermore, the "pocket trainer" is a flexible tool appositely created to be used during on-site work, remote work and outside working hours (Signorini et al. 2024). Finally, the role of the wellness coach (sports science graduate) represents the element to educate and personalize the UP150 experience while valorizing human relationships and social interactions (Signorini et al. 2024). Moreover, the wellness coaches operate as a "contagion," facilitating relationships among colleagues and managers and educating on healthy habits through need-supportive communication, fostering motivational processes linked to the self-determination theory (Deci and Ryan 2000; Fletcher et al. 2008; Yap and Davis 2007).

The UP150 project can determine the opportunity, on one hand, to acquire new scientific evidences and useful discoveries for population's health and wellness (Barab and Squire 2016), on the other hand to modify the "situated socio-cultural context" of the experimental environment (project's vision; Morales 2016). The changing of the experimental reality aims to explain how active breaks opportunely programmed (using an educative methodology) and inserted in the usual workflow can sustain the working performance favoring the vigor and avoiding the burnout (project's mission).

The literature analysis (theory-oriented), in line with the action research and the design-based research approaches (Hagan and Barron 2019; McNiff 2013), has considered:

- The specificity of previous physical activity workplace intervention (literature investigation);
- The educative theories and methodologies more favorable the realization of considered vision and mission.

The use of different pre-analysis studies (feasibility studies) allowed knowledge to be gained about the starting conceptual idea, orienting progressively to longer trial interventions with target groups increasingly close to companies' working reality (simulation proofs), and investigating the strength of the project over time (UP150 system thinking's robustness). Figures 1 and 2 evidence the structural elements (leverage points) characterizing the research project, based on a system thinking approach (Fig. 1) and their relationships to modify the historical- and cultural-based resistances (Fig. 2).

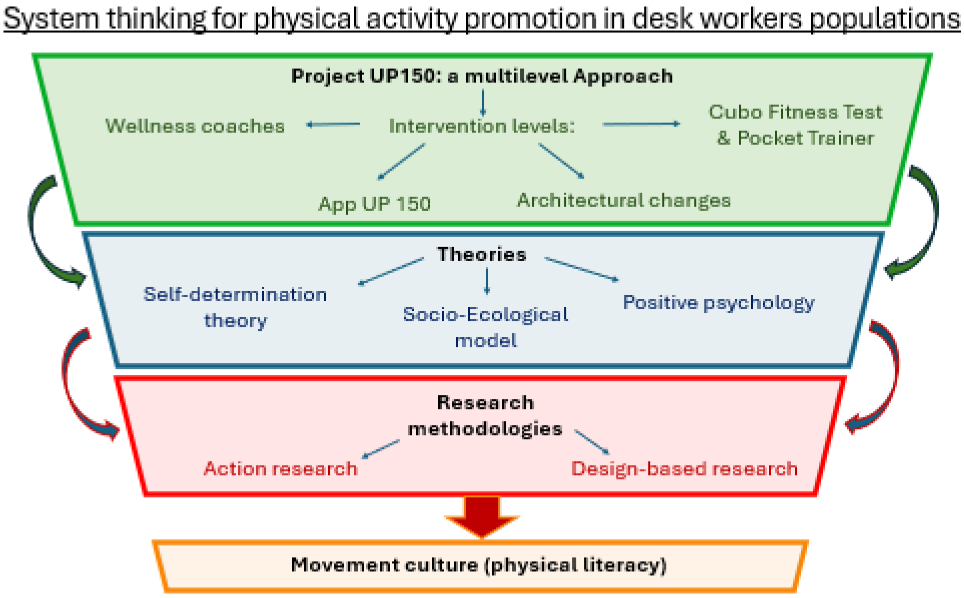

Figure 1. Research project structural elements' hierarchy

Figure 2. Research project constitutive elements (leverage point for the spread of working physical literacy) and relative connections. The color of each circle refers to Figure 1 structural division (green for multilevel approach elements, blue for the theories, red for the research methodologies and orange for physical literacy). Darker circles represent the main elements, while the lighter ones represent the constitutive elements.

Nevertheless, the modification of a structured and consolidated socio-cultural context must consider not only the possible leverage points that can facilitate the introduction of physical activity in the working complex system but also all those elements that can determine resistance to change. More specifically, the three problems (resistance points – fig.3) detected in this research field and considered as main system's resistance to change, are the following:

- People's common think consider the workplace an inadequate place to perform physical activity for personal fitness, health and wellness (Sigblad, Savela, and Okenwa Emegwa 2020),
- The companies' managers consider the increase of work breaks as time waste (Ryde et al. 2020; Sigblad et al. 2020),
- Employees are constantly involved in pressuring working tasks that impede to perform active breaks (Ryde et al. 2020; Sigblad et al. 2020).

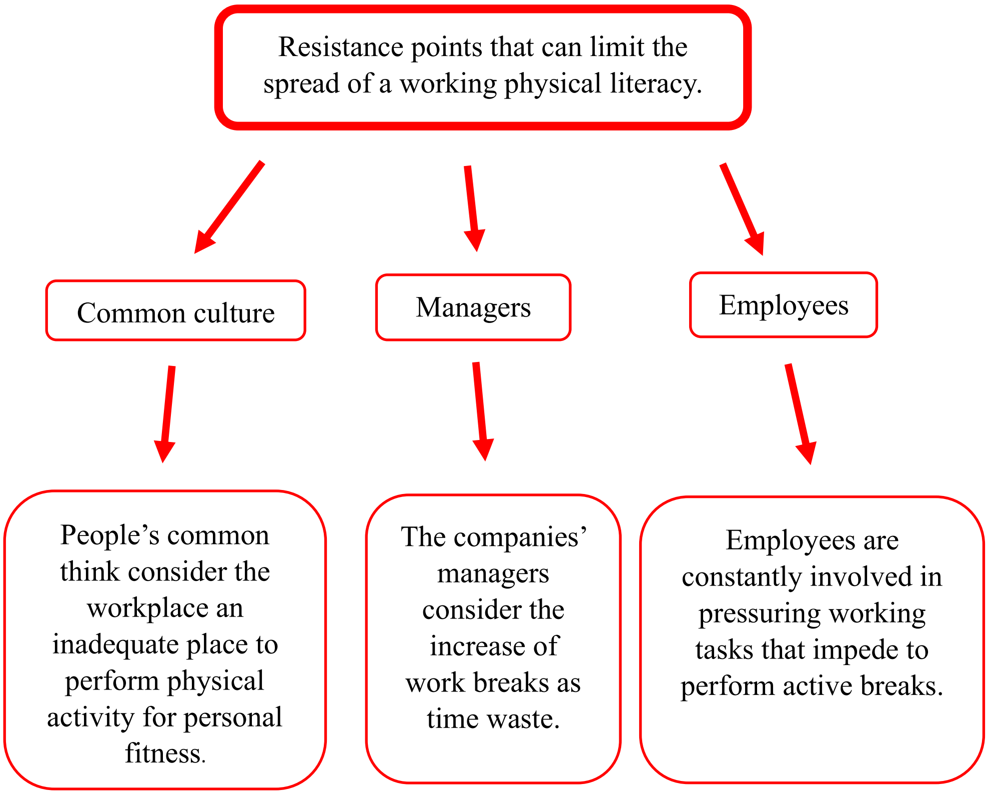

Figure 3. Resistance points that can limit the spread of a working physical literacy.

The following section highlights the project's roadmap, focusing on the intervention levels, the reference social theories, the research methodology, the main goal, and the approach used to implement a life-long movement culture in the working environment.

3. <u>Guide to project's road map</u>

The "UP150" is a multilevel project based on:

A. Four intervention level:

1. *Wellness coaches* (Blackwell et al. 2019):

   Have two assignments: i) use a need-supportive communication to adapt the project based on employees' personal needs; ii) instruct employees on the use of Cubo Fitness Test, UP150 app and the architectural changes to favor active breaks during usual workflow (Fig.4).

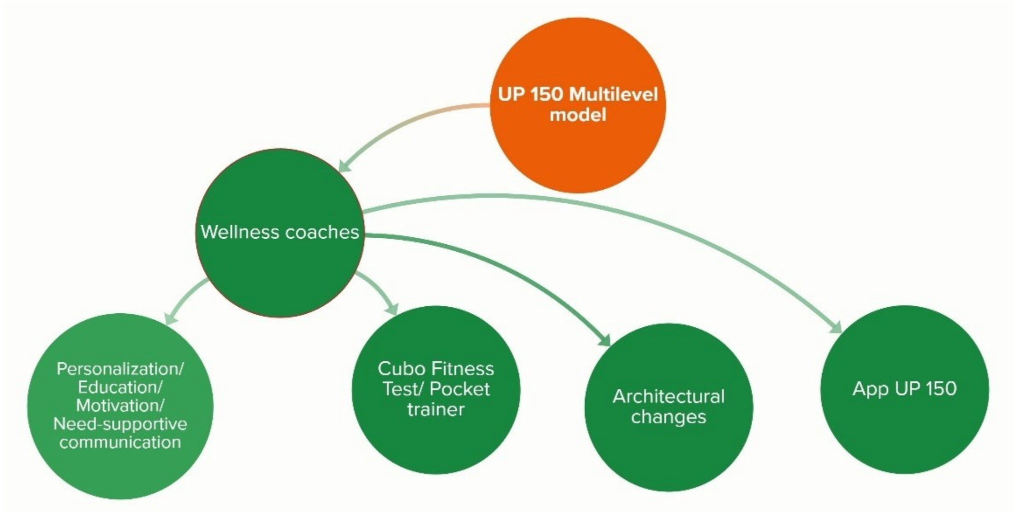

Figure 4. Wellness coaches' conceptual model

2. *Cubo Fitness Test (CFT) and Pocket Trainer (PT)* (Invernizzi et al. 2021)*:*

   Tools based on perceived exertion and normalized based on age, gender, and fitness level. They allow i) personalization of the training load, ii) to acquire knowledge, consciousness and autonomy about the adequate training methodology for own ability and characteristics (self-determination theory), iii) to set the target score of weekly physical activity (app UP150) (Fig.5).

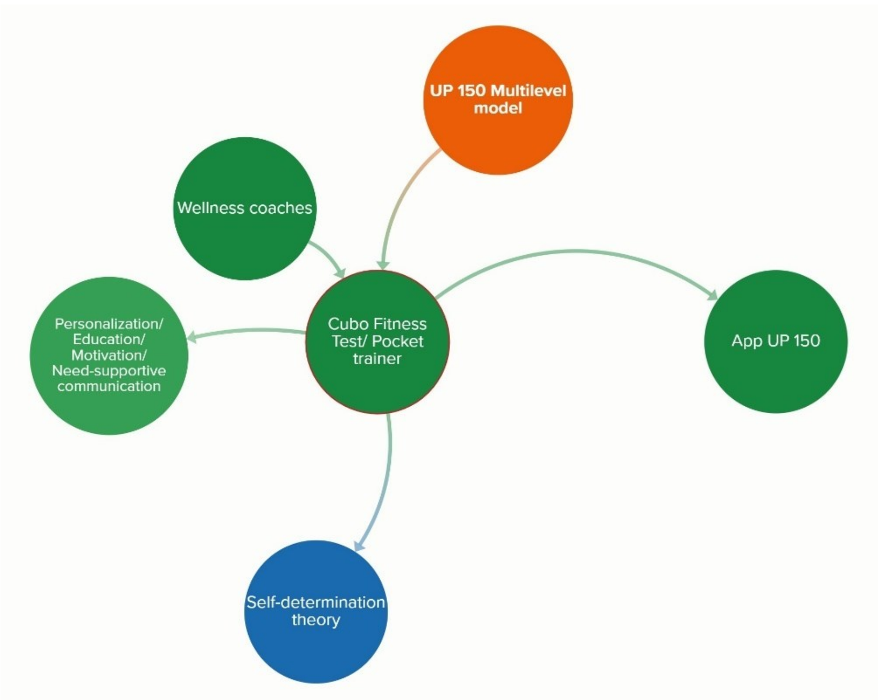

Figure 5. Cubo Fitness Test/ Poket Trainer's conceptual model

3. *App UP150*

Allows i) the monitoring of the weekly workload performed through a gamification's score system based on the connection with the CFT and PT, and ii) the direct verification of the on-site exercise influence (architectural changes) on the total workload through the connection with the active break stations (technology/gamification) (Fig. 6).

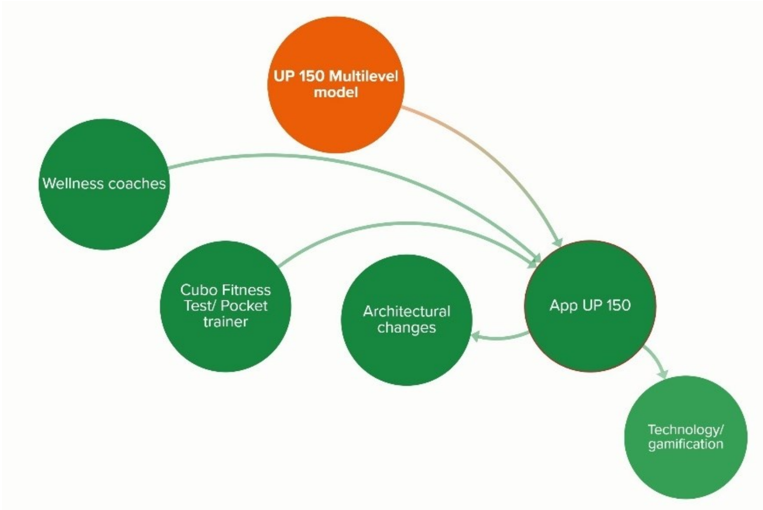

Figure 6. App UP150's conceptual model

4. *Architectural changes (active breaks stations)*
Through a structural modification of the office, the stations integrate action performed in the usual working environment with physical exercises in new and innovative ways (Fig. 7).

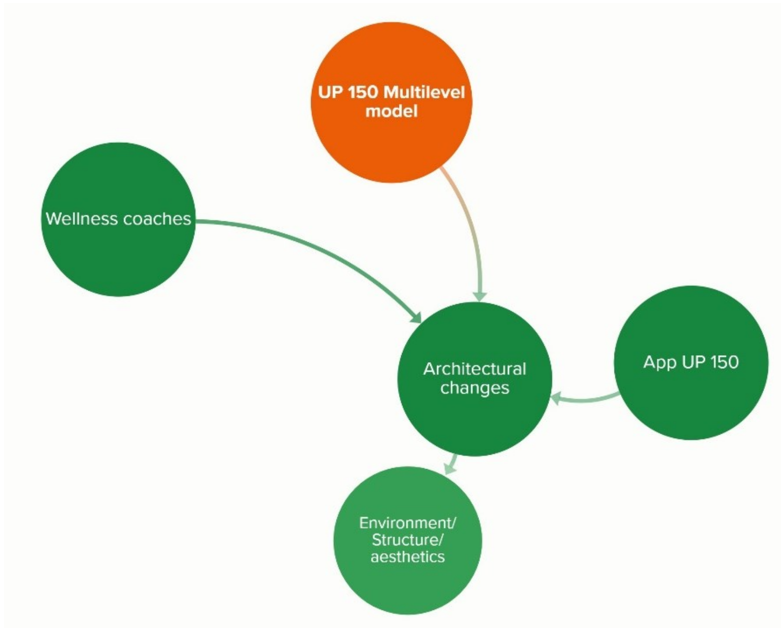

Figure 7. Active break station's conceptual model

B. Three reference social theories:

1. *Socio-ecological model* (Kilanowski 2017)*:*

Represent the link between individual/community and institutions/policy and adapt the adequate physical exercise for desk workers' needs to the corporate organizational structure (which can comprehend different solutions such as remote, on-site, and hybrid working; fig. 8).

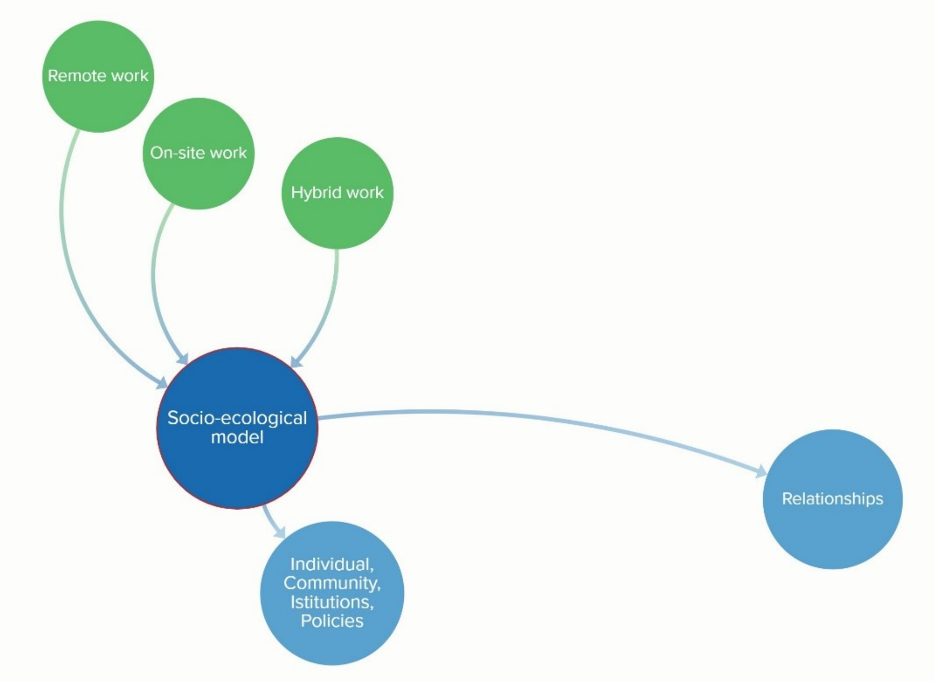

Figure 8. Socio-ecological conceptual model.

2. *Positive Psychology* (Seligman and Czikszentmihalyi 2000)*:*

Represents the referring theory for i) project the architectural changes (environment, structure, aesthetics) to favour physical exercise in tune with the idea of a technological, modern and pleasurable working environment; ii) promote the wellness coaches' empathic approach with the employees to communicate enjoyment, positive emotions, positive relationships and wellness in respect of their working experiences (Fig. 9)

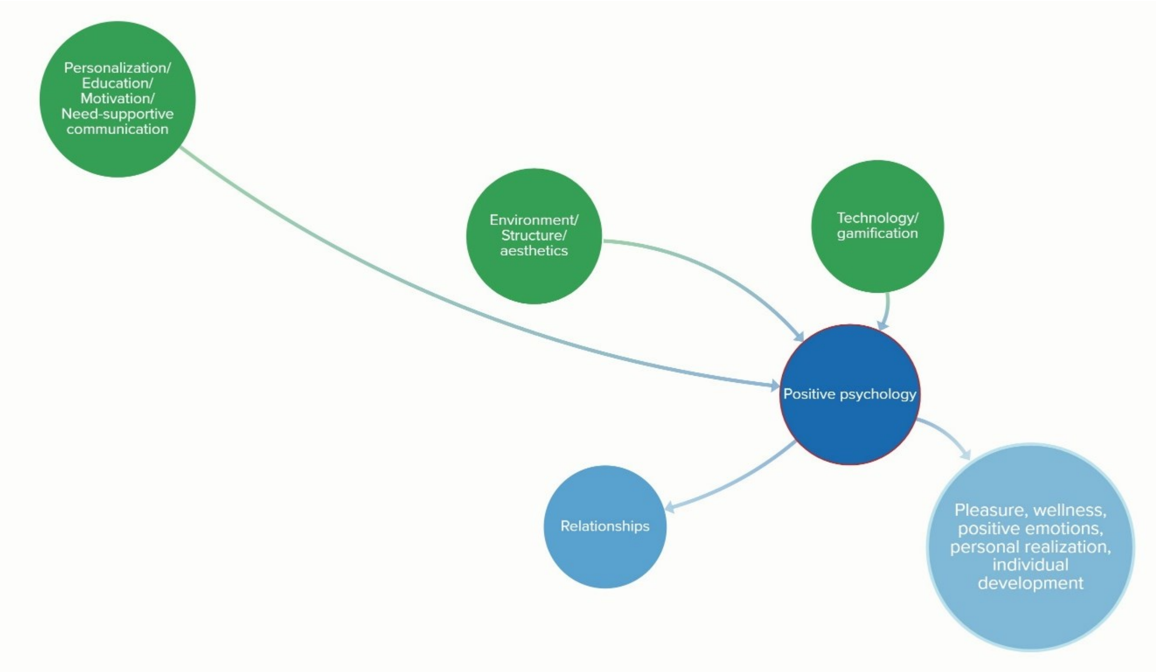

Figure 9. Positive psychology's conceptual model

3. *Self-determination theory* (Deci and Ryan 2012)*:*

Represent the reference point for an approach that promotes i) the employees' autonomous choice about the best physical exercise practice for their needs, ii) interpersonal relationships through the wellness coaches' need-supportive communication, iii) the personal competence (Cubo fitness test) that valorizes the employees' physical abilities through the self-perception which favour the self-consciousness (Fig. 10).

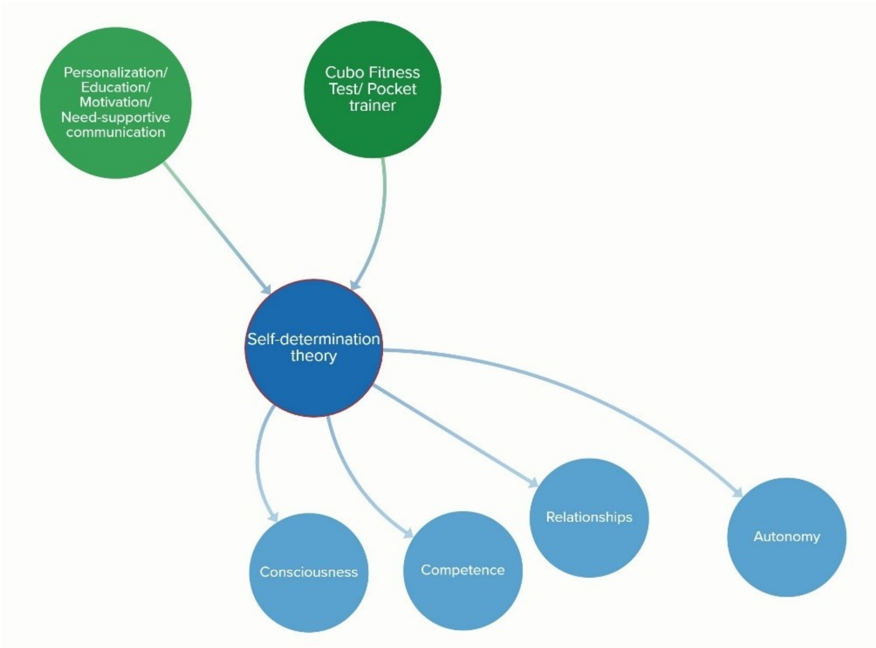

Figure 10. Self-determination theory's conceptual model.

C. Two research methodologies

1. *Action Research* (McNiff 2013)*:*

   Aims to modify the environmental reality, bringing personal wellness and professional skills to involved employees (Fig. 11).

2. *Design-Based Research* (Joseph 2004)*:*

   Implement knowledge about workplace intervention models to promote active breaks and good health practices (Fig. 11).

D. One research goal (working physical literacy culture)

1. *Physical literacy* (Whitehead 1993)*:*
   It is characterized by the monitoring and verification of a real, long-lasting acquisition of a physical culture and a motivation to adopt good health practices in the working environment (Fig. 11).

Figure 11. Action research, design-based research and Physical literacy's conceptual model

E. One research rationale

1. *System thinking approach* (Arnold and Wade 2015)*:*
   This represents the general conceptual approach based on boundaries, which are considered crucial elements for the inclusive choice of levels, theories, and research methodologies. These can constitute a "leverage point" to determine a cultural change in the "resistance points" that limit the insertion of active breaks in the working context (Fig. 12).

Figure 12. System thinking's conceptual model.

4. <u>Thesis' general structure (Project's design)</u>

In a research vision oriented to design-based research (Armstrong, Dopp, and Welsh 2020), the following chapters followed the design-based research iterative process (fig. 13), composed of analysis and exploration studies (where preliminary investigations gave knowledge about the context, the theories, and the research tools), design and construction studies (oriented to investigate the strength and weakness point of the UP150 concept), and the evaluation and reflection study (where the concept has been tested in a more realistic situation and where reflection for further analysis has been hypothesized). This research process can be compared to the steps that characterize a space mission. First, an initial feasibility study that groups information about the environment, tools and resources is needed (analysis and exploration studies). In the second phase, several space-ship launch simulation proofs are required to define the best spaceship's asset and launch program (design and construction studies). Finally, the best simulation is selected, and the robustness of the spaceship is tested before the actual launch (evaluation and reflection study). The entire process followed the vision of the action research (Hugentobler, Israel, and Schurman 1992), oriented to the modification of the working environment, and each study followed the rationale of the system thinking approach (Arnold and Wade 2015), analyzing a wide range of variable (and their relationships) that can influence the analyzed reality in order to promote healthy lifestyles and a long-term culture of movement (physical literacy).

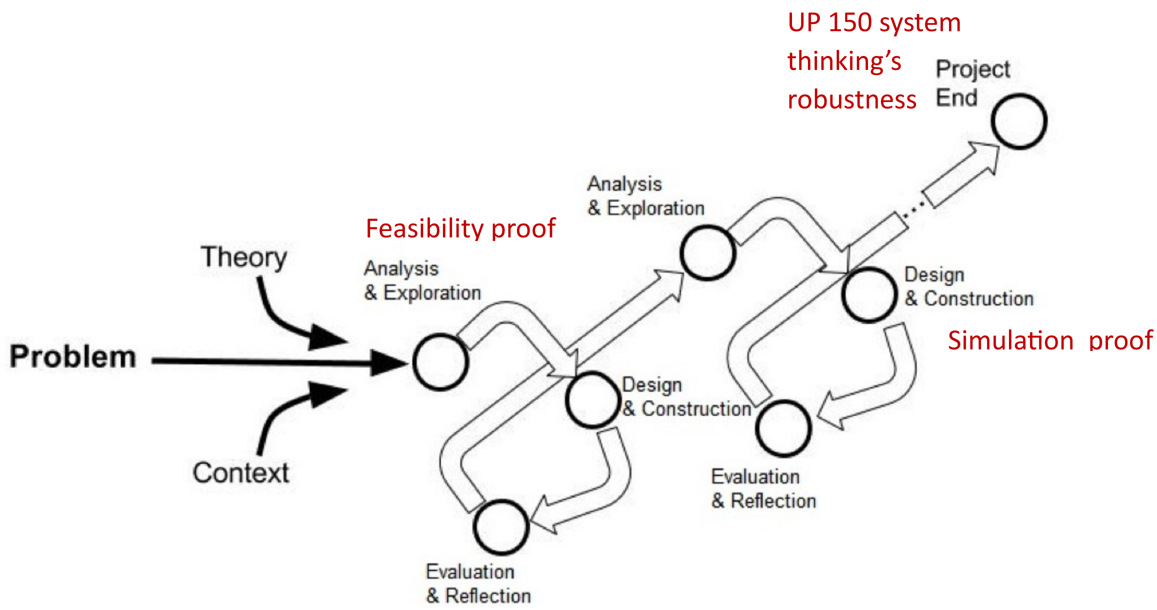

Figure 13. Design based research iterative process (Armstrong et al. 2020).

The present thesis shows six studies conducted classified into three main phases according to the design-based research:

1. Three analysis and exploration studies (that aim to set the primary knowledge of contexts and tools; feasibility proof)
2. Two design and construction studies (that aim to test the concept in a preliminary phase; simulation proof)
3. One evaluation and reflection study (that aims to apply the concept in a realistic environment to modify the working reality; UP150 system thinking's robustness)

Analysis and exploration A (*Step 1*)

Step 1 aimed to set the basis of the UP150 concept and to investigate preliminary validity of the Cubo Fitness Test (CFT; considered as main evaluation tool of the concept).

Children over “-enty -rty -fty”: gamification and autonomy as environmental leitmotif for “children of all ages” using a new workplace narrative.

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Abstract:

The "Ufficio Proattivo 150" project aims to assess a new workplace concept as an opportunity for individual development and health promotion, which differs from frequent beliefs that consider the workplace itself the cause of sedentarism or stress. By this rationale, new workstations plan to substitute the natural environment. Owing to innovative architectural solutions and specific equipment designs, the employees can exercise without interrupting the usual workflow. Individualized and adapted training programs support this user–place interaction in the spirit of gamification and distinguishing factories oriented at promoting the awareness of proper health practices of their employees. We designed a new portable and straightforward equipment, the cubo fitness test (CFT), which is based on exercising at submaximal intensity. It can be used in several environments: at home, in the office, indoors, and outdoors. A preliminary investigation assessed the validity and reliability of CFT. A total of 54 individuals (21 females and 33 males, 20.0 ± 4.2 years old, 65.0 ± 11.4-kg body weight, 1.74 ± 0.09 m stature, 22.0 ± 2.4 kg·m−2 body mass index) participated in this study. They were tested on cardio-respiratory and muscular endurance, flexibility, core muscular efficiency, shoulder mobility, and upper body strength; the obtained results were related to measurements performed using CFT. Overall, acceptable and good reliability were obtained in single tests ($r > 0.66$; $p < 0.001$), and moderate to good validity was observed ($r > 0.50$; $p < 0.001$). Low validity was found in the core muscular efficiency ($r = 0.44$; $p < 0.001$). CFT is a reliable instrument that contributes to developing consciousness, culture, and motivation toward physical activity. It provides knowledge of the advantages of good behaviour on the health status and quality of working life. This study confirmed that even mild and minimal exercise contributes to improving physical and mental health. Hence, the use of CFT in the Pocket Trainer intends to promote health at usual workplaces and in particular: i) Higher wellbeing levels (actual and perceived), ii) new awareness on properties of physical activity on health prevention and healthy lifestyle promotion.

Key Words: physical activity, perception, exercise, wellbeing, active lifestyle

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1. Introduction

It is a common belief that workplace (specifically office-like rooms) is a main cause of sedentarism or stress. A broad project called *Ufficio Proattivo 150* (inspired by the weekly minutes of moderate physical activity suggested by the World Health Organization, (WHO) has been recently designed with the aim to define new arrangements of the workplace concept as an alternative opportunity for individual development and health promotion (Altavilla 2016; D’Isanto, Manna, and Altavilla 2017). A pivotal component of this main project is represented by the sub-project *Pocket Trainer* (PT), which is based on the rationale of lifelong and life-wide learning and education related to different situational and environmental contexts. PT allows the complete planning, evaluation, and promotion of physical activity at the workplace. It can further challenge recent new habits in sports and exercise after changes owing to pandemic restrictions (Raiola et al. 2020). Briefly, PT consists of preliminary overall assessment, which provides an individual weekly score that need to be achieved by performing different types of physical exercises and activities (at the workplace, at home, indoors, and outdoors). After several weeks of exercising, a further assessment to check improvements (and to set an updated individual weekly score to achieve) is performed. PT is also part of the so-called "third mission" action that Italian Universities promote to connect academics to society. The local Ethical Committee approved PT, and the Open Innovation and Technology Transfer Office at the University of Milan supports its development. PT develops the paradigm of a "workplace that educates" the workers to be more physically active and self-confident in their level of physical exercise. It ultimately aims to improve the individual physical and mental health and wellbeing that can also lead to the subsequent increase in the efficiency and productivity of the workers. Several players work in synergy in PT: a university research group, an architecture and design studio, and a computer technology company.

1.1. Outdoor movement education and gyms (Prolegomena: gym as a surrogate of the natural environment)

Modern humans do not require the same body functionality of primitive men, whose motor abilities were essential to survival in the natural environment, searching for food, and keeping safe in the natural selective process (Ferrara 1992). However, currently, modern humans are still claimed to acquire several motor skills as our ancestors did. Human body, which is designed to overcome natural constraints, has not change over the centuries. However, it is necessary to practice motor actions to maintain health and operability (Nicolosi et al. 2010). In the outdoor environment, motor experiences are practiced by necessity and without protection, which increases risks associated with physical activity. By confining outdoor experiences to an indoor environment, gyms allow to exercise under more controlled conditions (and therefore under safety rules) to gradually acquire movements that modern humans are still not used to performing. Physical education teachers have designed gym equipment in which classic gymnastics served to maintain physical efficiency to reproduce in a safe setting the practice that the natural environment would have required, assuming it was the actual habitat again. Therefore, practitioners are gradually and adequately taught the movement, and risks of injuries are reduced. In addition, because skill requirements and demands evolve smoothly under indoor conditions than while exercising in the natural environment, less able practitioners more adequately tolerate exercise and benefit from the inclusive approach assured by this controlled activity. In the past, the lack of this progressive and structured opportunity to learn motor skills would likely have meant a natural negative selective process for weaker individuals. Pedagogy, instruction, and training methods further evolved and completed the educational chance of modern humans for recovering, developing, and achieving the otherwise missing motor abilities. While knowledge and circumstances to perform indoor or outdoor physical activities are available, the self-awareness of values to learn and keep moving is currently lacking. Actions, such as PT, intend to promote it starting from the workplace, where employees spend a large portion of their daily life.

1.2. Workplace as a school: a dissemination site for the culture of movement (Prolegomena: new frontiers of architecture)

According to Michel de Montaigne, *"the consciousness laws that are said to be born from nature come from habits,"* and *"common ideas that credit around us seem as general and natural laws."* (De Montaigne 2014) Based on these assumptions, workplace can serve adults as a dissemination site of education on movement (Ajibua, Olorunsola, and Alla 2013), which is similar to how school is for children, gym is for practitioners, and nature was for our ancestors. New architecture concepts and modern approaches create and reinvent the worksite environment, which promotes the employees' physical literacy and education on "motor normality" (intended as adequate human motricity) assured initially by the natural environment and then by the gyms. Owing to the pandemic, the worksite environment has extended to home during smart working. Therefore, employees are encouraged, motivated, and supported in exercising and, in particular, in experiencing physical activities during the usual daily workflow, which makes the worksite proactive and enhances workers' self-awareness approximately their level of physical efficiency (Gao et al. 2019; Jindo et al. 2019; Tsai and Wang 2016). In addition to the advantages for the workers, companies also benefit from the augmented physical exercise by the employees. Productivity, work performance, workability, and workers' mood improve (Brown et al. 2011; Grimani et al. 2019). Medical costs decrease by approximately $3.27 for every dollar spent on wellness programs, and companies' absenteeism costs decrease by approximately $2.73 for every dollar spent (Baicker, Cutler, and Song 2010).

1.3. Workplace that takes care of workers, a new narrative

What makes the workplace proactive? What encourages employees to exercise while working? How to make workers enjoy a new workplace narrative? PT embraces two concepts to answer these questions. First, the principles of intrinsic motivation and the self-determination theory served to plan PT and assure workers' autonomy in choosing the motor activity to perform (Deci and Ryan 1985). In a bold vision, employees can choose a more appropriate physical activity, a favourite place (e.g., office, home, outdoors, or indoors), or even not engage in the activity if the moment is not appropriate (e.g., not enough time, too much work/stress, or too tired). Moreover, the continuous practice and educational information on the sports activity create new physical competencies. Cooperating during the activity or only doing the activity collectively further enhance the method. Second, positive psychology (Crum, Salovey, and Achor 2013) and gamification (Robson et al. 2016; Sgro et al. 2019) promote exercising and make the activity exciting and enjoyable. When used in the daily workflow, gamification can encourage employees to engage in more physical activity. Game novelty, competitive and/or cooperative approaches generate appreciation and sociality, which further stimulates acceptable and durable motor practices for health and wellness. PT requires to record all physical activity practiced, even daily routine activity (e.g., carrying shopping bags upstairs or taking a dog for a walk). Each activity provides a score that is based on duration and perceived intensity. At the end of the week, scores are summed, and the final value corresponds to the weekly physical activity amount. There are several ways to measure physical activity. A suitable method to measure it is to implement physical activity-based technological systems in the typical workplace workflow. The employee interacts with workplace tools in a modified way to improve physical activity by small exercise practice (D'Elia et al. 2020; Jindo et al. 2019; Raiola et al. 2020). As previously described, to make the workplace proactive, PT considers: i) pedagogic, ii) architectural, and iii) technological variables.

i) *Pedagogic variables:* The paradigm of a "educative workplace" embodies pedagogic values. The primary intent is to set the "motor normality" for healthy adult individuals, which is human motricity that can be assumed as sufficient and necessary to avoid a debilitating status that increases risk of injuries and results in low quality of life. PT has been designed to properly lead physical exercise at the workplace by bringing an individual to and measuring such physical efficiency levels. PT is based on the cubo fitness test; its procedure, validity, and reliability are reported later. The second aspect to consider is related to professionals who are appointed to supervise the evaluation and training processes; these individuals should be identified (specialists in exercise sciences), allocated, and possibly engaged by the employers to act as competent facilitators to guarantee effective and enjoyable motor practices. Finally, methods and didactic strategies have to be defined to motivate and consolidate employees' participation; specifically, storytelling and cooperative learning best serve this purpose and are the primary approaches of PT.

ii) *Architectural variables:* Changes in the workplace environment are the second pillar of PT. Implementing physical activity-based technological systems in the typical workplace flow should help the employees easily engage in physical activity during working hours.

Equipment, which is specifically built to induce exercise to accomplish the workflow, reproduces at the workplace facilities that are present at the gyms.

iii) *Technological variables:* The development of a dedicated app for mobile devices and a technological system for detecting and recording physical activity is the main focus of technological variables. The app has to communicate with the office's technological devices that generate a database of any employee's physical activity. In this way, employees obtain individual performance parameters for personal gaming or collective competitions under the gamification approach, with due regard to privacy policies.

1.4. Developing and maintaining education on the movement

The previously described structure of a proactive workplace to promote physical activity first requires tools and criteria to measure and monitor the exercise. Cubo fitness test (CFT) is a testing procedure that is performed with portable and straightforward equipment (a cube) designed to be used in any environment: at home, in the office, indoors, and outdoors (Figure 1). It allows to exercise and test cardiovascular endurance, flexibility, core muscles, shoulder mobility, and the upper body's strength. The testing procedure lasts 10 min at maximum and requires efforts of moderate intensity. Anyone can easily tolerate submaximal engagement; it can be performed without specific apparel, and safety is guaranteed. Hence, this first preliminary investigation aimed to assess the validity and reliability of CFT.

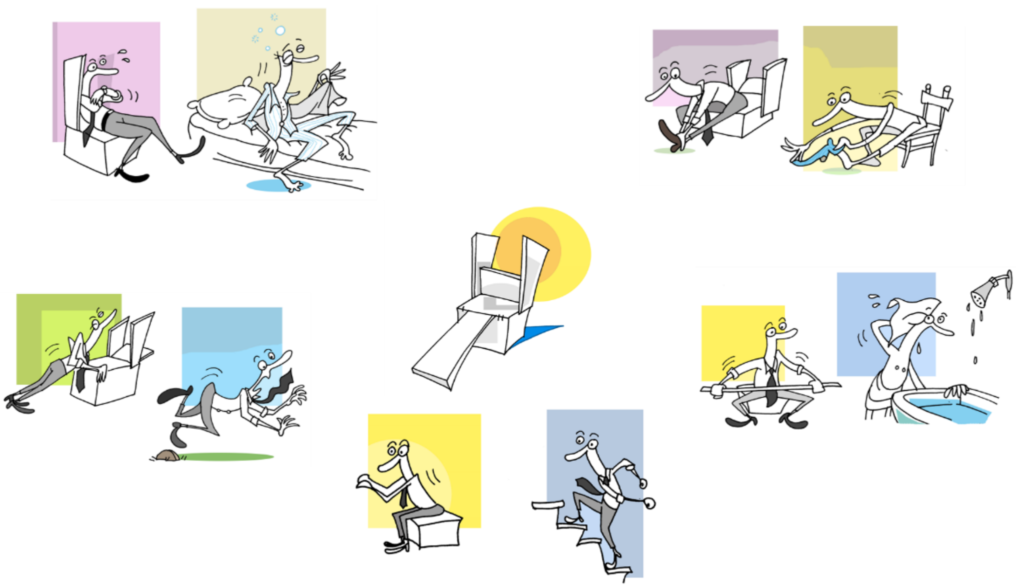

Figure 1: Cubo fitness test. The equipment (in the middle) and examples of home and office applications for exercising and testing motor normality.

2. Methods

2.1. Participants

A total of 54 individuals (21 females and 33 males, 20.0 ± 4.2 years old, 65.0 ± 11.4 kg, 1.74 ± 0.09 m, BMI of 22.0 ± 2.4 $Kg·m^{-2}$) participated in the preliminary investigation. After receiving explanations of the study's aims and procedures, they signed an informed consent to participate. The study was conducted by following the Declaration of Helsinki for the Humans Rights and was approved by the Milan University Ethics Committee.

2.2. Procedure

All participants arrived at the didactic laboratory on four different days (one week between testing) at the same time of the day; they observed rest or had a very light exercise in the days before the tests. The first session was used to familiarize the participants with the test procedure. The fourth session was finally carried out to administer tests at the maximal effort. Every participant performed in the same order five submaximal tests composing CFT. Tests and procedures were applied according to Crotti, Bosio, and Invernizzi (Crotti, Bosio, and Invernizzi 2018), and Invernizzi, Signorini, Bosio, Raiola, and Scurati (Invernizzi et al. 2020). The Ruffier test (Sartor et al. 2016) assessed cardio-respiratory and muscular endurance. The participants were asked to perform 30 half squats paced by a metronome to be executed within 45 s. Heart rate at rest, immediately after the end of the test, and after 1 min of recovery were the outcome measures. The half squat's deepness was standardized using a purpose-built device to perform CFT. The sit and reach test assessed hip flexibility (Baltaci et al. 2003). According to the protocol, the measures were positive or negative based on participants' forward flexion, i.e., sliding hands below or above the foot reference level, respectively. Right and left hip flexibility was assessed separately and successively averaged. Sit-up exercise measured the core muscular efficiency (Bianco et al. 2015). The number of sit-ups was counted. The shoulders' mobility was assessed through the upper limb rotation while holding a stick by measuring the distance of the hands' grip during the rotation (Harre 1977). The push-up test provided information about the upper body strength (Pescatello 2014). The number of push-up repetitions was recorded. All tests were performed using the purpose-built equipment that was designed and explicitly realized for CFT. Apart from the Ruffier test, in which the experimenter set the pace, the participants had to perform all tests at submaximal intensity. They were asked to exercise up to the score of 5 AU on the Borg's CR-10 scale of perceived exertion during sit-ups and push-ups, and at the 100-AU score level on the stretch intensity scale during the sit and reach and shoulder mobility measurements (Invernizzi et al. 2020). After each test, participants recovered for two minutes before continuing the procedure. During the fourth session, the same tests were repeated at the maximal intensity, apart from the cardiovascular endurance evaluation for which the YOYO IR1 intermittent running test was used (Bangsbo, Iaia, and Krustrup 2008).

2.3. Statistical analysis:

Test–retest reliability (Intraclass correlation, ICC) was assessed from scores obtained during the second and third sessions. The correlation coefficient (r) between the best scores achieved in sessions 2 and 3, and the results of maximal tests were calculated to determine the validity of the construct of CFT. The correlations between heart rate immediately after the Ruffier test and maximal heart rate during the YOYO test were also examined.

3. Results

The overall CFT results are summarized using an arbitrary "normal motricity index." The index ranges from 0 to 100, and two cut-offs of 33 and 66 are arbitrarily used to determine low (0–33), medium (34–66), and high (67–100) levels. The percentage distribution of individual scores resulted in 2% at the low level, 87% at the medium level, and 11% at the high level. Overall, acceptable and good reliability was observed in single tests ($r > 0.66$; $p < 0.001$), and moderate to good validity was observed ($r > 0.50$; $p < 0.001$). Low validity was observed in the sit-up test ($r = 0.44$; $p < 0.001$).

4. Discussion

4.1. The concept of "motor normality"

As highlighted in the introduction section, human body could attain the necessary motor efficiency that provided survival functionality in the past. Currently, motricity represents the means to preserve health and wellbeing, provided that it is performed, and that sedentary behaviour does not take over. When this occurs, our body decays and becomes prone to diseases and injuries, and even trivial accidents (e.g., falls) represent sources of risk. Having an acceptable physical efficiency that allows to overcome health deterioration and most common events that otherwise cause injuries (e.g., insufficient upper body's muscular strength to mitigate a fall; too low flexibility to widen the support base and counteract a loss of balance) represents the so-called "motor normality" (Figure 2).

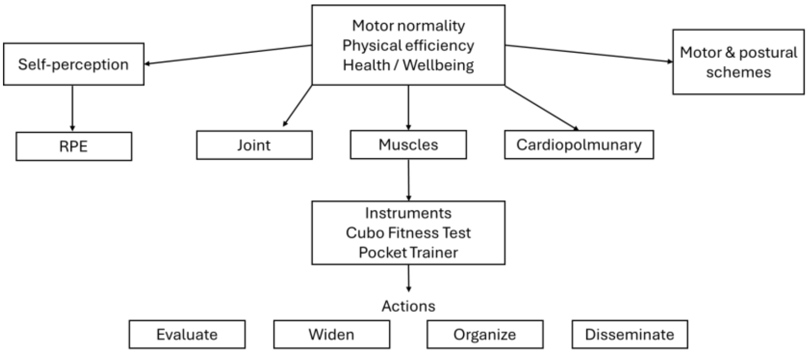

Figure 2: The "motor normality" meaning framework.

Motor normality also considers the awareness and perception of one's own body, skills, and abilities. From the previous example, it is easy to understand that individuals need to be correctly conscious about situational constraints and actions to perform, sustain, or undertake to address the requirements. Therefore, exceeding efforts can be avoided, safety preserved, and understanding of the actual functional status fully realized. Thus, PT and CFT meet the demand to help to set the motor normality level. They base the rationale on some deal-breakers: perception and functionality. Using perceived exertion scales while exercising and performing testing procedures, ordinary decisional habits in acknowledging tasks' demands and responses arise and sustain perceptual abilities. Using PT and CFT, the functional normality level can be arranged, and the most appropriate dosages can be determined for each feature. Concerning flexibility and shoulders' mobility, an acceptable condition of normality reasonably lies between rigidity and joint instability. In particular, everyday functional movements should be enabled, at all ages, to overcome limitations caused by growth (e.g., unsynchronized development of bones and muscular/ligament lengths in children's evolutionary stages) or by muscular rigidity occurring in the elderly. Unacceptable limitations occur when adults cannot raise the arms to reach an object placed overhead, when they cannot put on a jacket or cannot easily brush their back with a sponge, or when they cannot flex forward enough to put on socks. PT and CFT specifically test, train, and teach these skills at submaximal effort conditions, which preserves standard functionality. Similarly, muscular strength and endurance are normal when climbing up and down the stairs without fatigue, which corresponds to the half squatting CFT exercise. In addition, CFT sit-up and push-up procedures indicate motor normality levels corresponding to the core strength required when getting out of bed and when protect against a fall by absorbing the impact on the soil. The objective of PT and CFT is to promote physical activity at the workplace and to reduce sedentarism. Some actions outline their articulation and application (Figure 3).

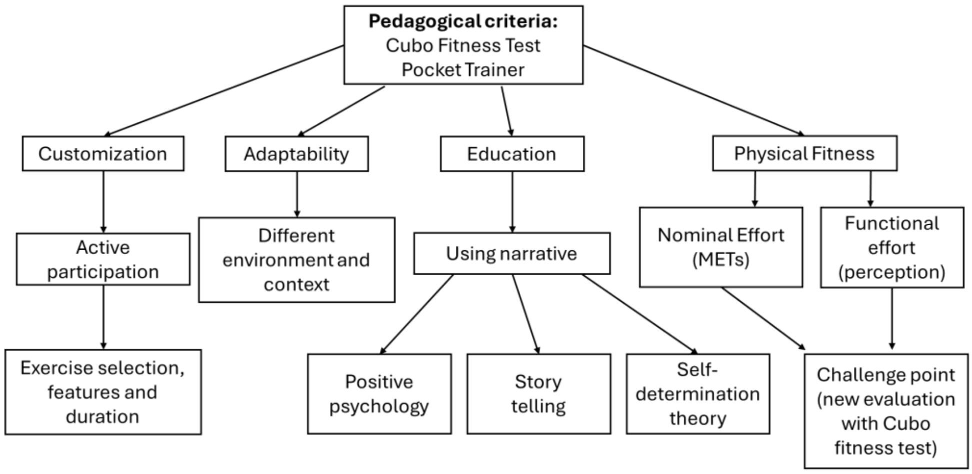

Figure 3. "Pedagogical criteria" framework.

4.2. Evaluate

Evaluation is the first and essential step. it determines the starting functional point, increases consciousness in self-ability, and promotes motivation (Black and Weiss 1992). Using CFT and repeating evaluations regularly are crucial in providing adequate monitoring of employees and potentially enhancing the PT method and the awareness of good health and physical activity practices (Figure 4).

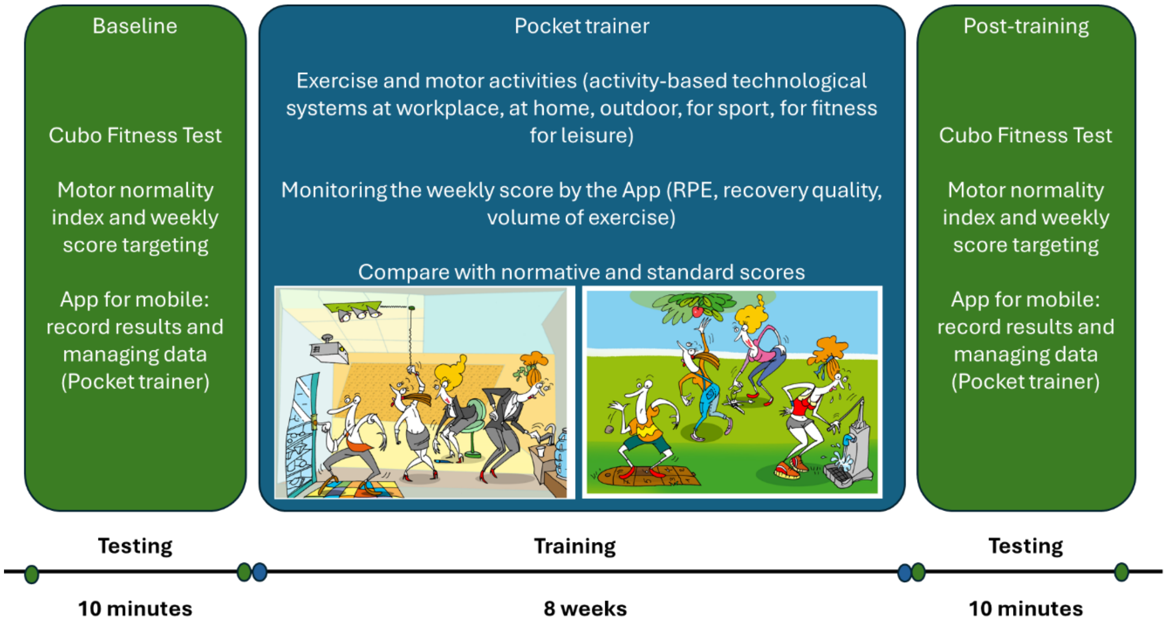

Figure 4. Timeline of the application of the cubo fitness test and pocket trainer.

4.3. Widen

To properly develop adequate motor normality that allows employees to preserve high quality of life, itis necessary to increase exercise opportunities. Therefore, widening means changing the workplace by offering more exercise and physical activity, both related to the physical office space (outdoor, indoor, at the office, at home during smart-working) and technological devices. To better distribute physical activity during the day, it should be split into five features describing the motor normality: self-perception (i.e., RPE detection); articular, muscular, and cardio-respiratory fitness; motor and postural schemas. These areas characterize different moments or sites within the workplace that have to be structured to embrace all features of motor normality.

4.4. Organize

The CFT monitoring procedure ensures the detection of most critical aspects connected to the expected employee's motor normality so that the necessary volume and type of exercise can be organized. The index of motor normality obtained from CFT further indicates the minimum amount of weekly points to earn to reach or maintain motor normality. Owing to individual scoring, information about less efficient areas that need to be improved is obtained. Employees can select which activity better fits their condition and adapt daily routines to individual requirements.

4.5. Disseminate

Completing PT and CFT using apps for mobile devices and implementing the integration in the workplace architectural design, improving benefits, and lowering employer costs represent the primary source of dissemination of the project.

5. Conclusions

CFT is a reliable instrument that trains and evaluates at submaximal intensity the following characteristics, i.e., cardio-respiratory and muscular endurance, flexibility, core muscular efficiency, shoulder mobility, and upper body strength. Owing to its portability and easy-to-use application, it can be included in the new workplace concept of the "Ufficio Proattivo 150" project and integrated into the usual employee workflow. CFT contributes to developing awareness, culture, and motivation toward physical activity starting from the workplace by providing knowledge of the advantages of good behaviour on the health status and the quality of working life. CFT helps PT to achieve health status benefits and recover, reach, and maintain motor normality that sedentarism or actual lifestyle lost compared to the past situation. Improved wellbeing levels (actual and perceived) show that a new vision of workplace.

Analysis and exploration B (*Step 2*)

Step 1 gave information about an initial validity of CFT, moreover it created the conceptual theoretical base for the UP150 project's structure. As the CFT represent one of the main fundamental pillars of the UP150 concept, *Step 2* aimed to investigate more deeply the validity of the CFT in mental fatigue condition and in several perceived intensity domains.

Effect of cognitive load and different exercise intensity on perceived effort in sedentary university students: a follow up of cubo fitness test validation.

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Abstract

Work and intellectually fatiguing environments can significantly influence the health of individuals, which is strictly bound to motor efficiency. In particular, desk workers and university students may have a sedentary lifestyle and a condition of mental fatigue caused by daily routine, which could impair motor efficiency. The assessment is a starting point for enhancing awareness of the individual's psychophysical condition through the perception of one's body motor efficiency, motivating to move towards improvement. This way, a submaximal test based on perceived exertion was developed (Cubo Fitness Test, CFT) and validated in previous studies. Hence, two further studies were employed to enhance the consistency and accuracy of this instrument in different conditions. The first study investigated the internal responsiveness of CFT, evaluating if mental fatigue could affect motor efficiency. The second study investigated which perceived intensity (weak, moderate, strong, or absolute maximum) could be more reliable for applying the CFT (as previous research focused the investigation only on moderate intensity). In the first investigation, participants assessed two stimuli (mental fatigue induced with a Stroop color-word task and a neutral condition based on the vision of a documentary) lasting 60 min each. The quality of psychophysical recovery (total quality recovery) and the mood state (Italian Mood State questionnaire) were evaluated before the stimuli. After the fatiguing or the neutral task, the mood state was newly assessed, together with the evaluation of the workload's characteristics (Nasa TLX) and the CFT motor efficiency. In the second investigation, participants had to perform CFT twice for each at different intensities of Borg's Scale of perceived exertion. Researchers successfully requested to fill out the NASA TLX questionnaire regarding the perceived workload characteristics of CFT, and the reliability of each intensity was assessed. Results seem to enhance the consistency and the accuracy of the instrument. Indeed, findings evidenced that CFT is not influenced by mental fatigue conditions typical of the intellectual work of desk workers and university students for which this test was specifically conceived. Moreover, moderate and strong perceived intensity are the most adequate conditions to assess motor efficiency in these populations.

Keywords: mental fatigue, workload, sedentary lifestyle, CFT, NASA-TLX, cardio-respiratory and muscular endurance, flexibility, core muscular efficiency

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1. Introduction

Desk workers and university students typically live in physical inactivity and sedentary conditions. These populations are estimated to sit around 10 h per day during working and class activities, respectively (Castro et al. 2020; Clemes et al. 2016; McCrady and Levine 2009). These sedentary behaviors have been further exacerbated by the COVID-19 pandemic in both populations (Dziewior et al. 2022; Ráthonyi et al. 2021). Sedentary and intellectual working environments have a significant influence on individuals' health. It suffices to think that sedentary occupations are associated with increased cardiovascular risk and a higher likelihood of developing musculoskeletal diseases (World Health Organization 2018). These occupations are also associated with worse mental health and with an increased risk of developing depression, anxiety and dementia (Lee and Kim 2019; Teychenne et al. 2010; Teychenne, Costigan, and Parker 2015; Yan et al. 2020). In particular, in the last years, university students are reported to have doubled symptoms of depression and anxiety due to their workload (Prince 2015). Indeed, as for desk workers, students' workload is determined not only by the number of study hours (dedicated explicitly to memorizing information and reasoning) but even by the time pressure, which increases stress and negative feelings (Smith 2019). Given the beneficial effect that adequate levels of physical activity have on psychophysical health, one of the main aims for the health promotion in students and desk-workers population should be the subsistence of adequate levels of motor efficiency, defined as physical and coordinative abilities which determine less effort in producing performance (Herbert et al. 2020). It represents a crucial element to maintain a lifespan physical autonomy (Invernizzi et al. 2020; Lay et al. 2002). Indeed, the subsistence of adequate levels of conscious physical fitness and economy in movement energy expenditure constitute key elements to keep body awareness, physical autonomy, and high quality of life (Duda et al. 2014; Furtado et al. 2015; Graves and Larkin 2006; Sumpter, García González, and Pozo Cruz 2015; Tornero-Quiñones et al. 2020). Given these considerations, workplaces and universities must prioritize health promotion and physical activity, supporting individuals to develop a comprehensive understanding of their bodies adopt competent management practices, and maintain adequate motor efficiency (Plotnikoff et al. 2015; World Health Organization 2018). The assessment is a starting point for enhancing awareness of the individual's psychophysical condition through perception of one's body motor efficiency, motivating to move towards improvement. (Invernizzi et al. 2021). Accordingly, relying on valid and practical tests is imperative to assess motor efficiency in people engaged in predominantly sedentary activities. The Cubo Fitness Test (CFT) is a diagnostic tool developed to assess motor efficiency. The optimal reliability and good criterion validity of CFT with university student and desk-worker populations was previously confirmed by Invernizzi et al. (Invernizzi et al. 2021, 2022). The CFT is performed at a sub-maximal intensity (perceived as moderate from rating of perceived exertion scales) requiring a short time to be accomplished (without sophisticated and expensive equipment). The index of motor efficiency resulting from the five physical components tested (Cardio-respiratory fitness: Ruffier test; Muscular fitness: push-up and seated sit-up tests; Flexibility fitness: shoulder mobility and chair sit and reach tests) is the primary outcome of the CFT. It provides valuable parameters for possible physical activity interventions, such as the UP150 (workplace physical activity implementation project: "UP" stands for the Italian acronym that can be translated in "proactive office," and "150" represents the 150 minimum minutes of moderate physical activity recommended by the World Health Organization for sedentary or less active people) project (Invernizzi et al. 2021; World Health Organization 2020). Desk workers and university students spend a significant amount of time on cognitive and mental demanding activities (Frone and Tidwell 2015). Intense cognitive tasks performed for several minutes can lead to increased subjective feelings of tiredness and decreased cognitive performance, also defined as mental fatigue (Marcora, Staiano, and Manning 2009). Further studies reported that acute and chronic mental fatigue could induce negative mood while bringing mental and physical health problems, respectively (Smith et al. 2016). More specifically, university students' mental workload is even demonstrated to influence their sleep and cognitive functions (Mizuno et al. 2011; Rutala et al. 1990). In the above contexts, in order to improve working conditions and lifestyles, it would be desirable for individuals to be aware of the disadvantages of a sedentary lifestyle in terms of physical and mental condition. This would lead to a change toward healthy daily habits can take place, achieving and maintaining good levels of physical literacy (Whitehead 2013). In this perspective, the CFT is advantageous because it allows knowledge and, thus, awareness of the physical fitness status of individuals. In addition, it is based on effort perception scales, which guarantee the tested subjects' safety and prevent occupational injuries and illness. The body perception is particularly favorable for the promotion of physical literacy and exercise educations (Pastor-Cisneros et al. 2021). Indeed, these educations should always consider the individual psychophysical characteristics and act in agreement with actual body condition (Birnbaumer et al. 2022). Only with this awareness, individuals could independently choose appropriate activities through lifespan (Deci and Ryan 2000; Finch and Owen 2001; Invernizzi et al. 2022). Perceived exertion refers to the perception of how hard, heavy and tiring a specific physical task is (Marcora 2010). It mainly refers to the sensations concerning dyspnea and how hard a person drives his/her active limbs. The perception of effort is beneficial as an indicator to monitor the effect of a predetermined exercise based on an external load and to modulate the exercise. This tool can be utilized whether the subject is an athlete or a patient undergoing a rehabilitation or training program. The perception of effort allows immediate feedback on the internal load of an exercise. To do this, numerical or visual scales are used, often assisted by verbal anchors to which the subject can refer, which are very effective in providing a value that reflects the perceived exercise intensity (Razon, Hutchinson, and Tenenbaum 2012). Given these considerations, when conducting a physical performance test to promote physical activity and educate on good practices for health in these intellectual sedentary contexts, it is necessary to consider whether and how much mental fatigue may affect the test outcome. Some studies (Van Cutsem et al. 2017; Grgic, Mikulic, and Mikulic 2022; Pageaux et al. 2014) highlighted that mental fatigue negatively affects physical performance. Mental fatigue can cause changes in technique, decision-making, skill execution. The negative influence on physical performance has mainly been attributed to an increased perception of effort (Smith et al. 2016). Therefore, from these considerations it emerges that the CFT must be able to give objective evaluations in specific sedentary contexts regardless of the fluctuations in mental effort during the different periods of the year (Invernizzi et al. 2022). Indeed, the CFT should work in specific environments where mental fatigue represents a typical condition of the individuals' daily routine (Invernizzi et al. 2021). The CFT protocol assumes that sub-maximal effort (moderate perception of effect) is administered to participants. There are many advantages to using sub-maximal tests (defined as a test that conduct the participant to a predetermined level of intensity compared with and below the maximum capacity; Shushan et al. 2022), including greater safety and the possibility of testing people who are not accustomed to exercise and who find it challenging to tolerate maximal-intensity exertion, making it possible to extend measurements to sedentary participants. Table 1 shows the current status of the CFT validation process. The present study will progress the CFT validation process. In the first study (Study 1), we investigated the internal responsiveness (defined as the ability of a measure to change over a particular prespecified time frame or condition) stating that an absence of it determines a highest degree of the test's consistency and accuracy in measuring populations subjected to acute mental fatigue (as desk-workers and university students; Husted et al. 2000). After that, in a second study (Study 2), we examined at which intensity of perceived exertion (weak, moderate, strong, or absolute maximum) the CFT shows the highest relative reliability (defined as "degree to which individuals maintain their position in a sample with repeated measurements"; Impellizzeri and Marcora 2009). Moreover, in this last study, the intensity-induced changes in the perception of test load's characteristics were further investigated.

Table 1. Status of the validation process of the Cubo Fitness Test.

Validation process		Status	Publications
Conceptual and measurement model		Investigated	Invernizzi et al. (2021)
Validity	Logical validity	Investigated	Invernizzi et al. (2021)
	Criterion validity	Investigated	Invernizzi et al. (2021)
	Construct validity	To be investigated	Future investigation
Reliability		Investigated	Invernizzi et al. (2021, 2022)
Responsiveness	External	Investigated	Invernizzi et al. (2022)
	Internal	To be investigated	Present publication (Study 1)
Reliability of alternative forms		To be investigated	Present publication (Study 2)

The validation process follows the procedure by Impellizzeri and Marcora (Impellizzeri and Marcora 2009).

2. Study 1

Study 1 aims to examine the internal responsiveness of CFT, ensuring that mental fatigue does not affect the CFT results. Considering research by Marcora et al. (Impellizzeri and Marcora 2009), which claims that mental fatigue can affect effort perception and physical performance, we wanted to test whether CFT results would be affected by mental fatigue due to intense cognitive load from work or study. For this purpose, participants, after a familiarization period, were subjected to two experimental sessions, lasting 60 min each, with mental fatigue and neutral stimuli in a randomized manner. Before assessing CFT, we measured the participants' quality of psychophysical condition, mood and task workload.

2.1. Methods study 1

The sample size required for Study 1 was evaluated using the statistical software G*power. It used the T-test category selecting "MEANS: the difference between two dependent means (Matched pairs)." The Cohen's dz. effect size was set at 1.08, calculated from the outcomes of a previous study that investigated the changes in Cubo Fitness Test results (the principal variable investigated in the present study). The estimated power, 1-β, was set at 0.95 and the alpha value at 0.05. With these inputs, the software indicated 11 participants as adequate sample size (Actual Power = 0.953). We decided to recruit 18 participants to prevent the reduction of the statistical power caused by possible dropouts. The sample comprised 13 male and five female university students 21.6 ± 2.5 years old. The sample can be considered as normal weight (weight: 72.0 ± 11.8 Kg; Height: 1.75 ± 1.0 m; BMI: 23.5 ± 2.7 kg/ m^2). This study included sedentary university students who spent at least 7 h/day studying or attending university lessons while excluded students who regularly practiced sports or physical activity during free time. The analysis of physical activity habits was performed using the International physical activity questionnaire (IPAQ), as will be explained later. The study was conducted in accordance with the declaration of Helsinki and was approved by the ethics committee of the University of Milan (14 September 2020, number 84/20).

2.2. Procedure

Participants underwent a three-day familiarization period with all tests and questionnaires. After 48 h, they participated in two experimental sessions, including mental fatigue stimulus (MF) and a neutral stimulus (NS), 1 week apart (Penna et al. 2018; Staiano et al. 2019). To avoid unwanted effects due to the sequence of the proposed stimuli, the order of administration of the two stimuli was randomized (using the site www.randomization.com) for each participant. Participants were recruited after the administration of the IPAQ questionnaire. Before the beginning of the experimental protocol, participants were required to come to the experimental session with sufficient psychophysical recovery, measured using the Total Quality Recovery Scale (TQR). Immediately after the compilation of the TQR, the participants were asked to answer the Italian version of Brunel's mood state questionnaire (ITAMS). Afterwards, participants received the expected stimulus (MF or NS) for 60 min. At the end of the stimulus, the participants filled out the Nasa TLX questionnaire to evaluate the typology of load created by the proposed stimulus. Finally, the participants performed the Cubo Fitness Test (CFT).

2.2.1. *International physical activity questionnaire*

The International physical activity questionnaire (IPAQ) is a validated helpful questionnaire to assess the participants' weekly physical activity (Craig et al. 2003). The candidate must answer the questionnaire about the activities performed the previous week. The questionnaire returns the weekly amount of activity measured in METs. The cut-off suggested by Craig et al. (2003) to define the profile of the participants is (a) sedentary < 700 METs; (b) 700 METs < minimally active <2,519 METs; (c) Highly engaging in physical activity >2,520 METs.

2.2.2. *Total quality recovery scale*

The Total quality recovery scale (TQR) is a validated scale used to evaluate the psychophysical recovery state (Kenttä and Hassmén 1998). The scale has been used in previous studies to assess psychophysical recovery before performing the CFT (Invernizzi et al. 2021, 2022). The TQR scale is composed of a range of values from 6 to 20 with verbal anchors based on recovery status (from "very, very poor recovery" to "very, very good recovery"). The participants are asked to select the verbal anchor that better address the psychophysical recovery at a specific moment (soon previous to the execution of the CFT), then the participants indicate a number from the scale close to the chosen term (i.e., participant feels his recovery as good, so he/she indicates the value "15" which is close to the verbal anchor "good recovery"). To begin the experimental procedure, the participant has to indicate a minimum value of reasonable recovery (number 13).

2.2.3. *Mental fatigue*

To induce the state of mental fatigue (MF), the participants performed a fatiguing stimulus by the modified Stroop colour word task for 60 min (Al-Shargie et al. 2019). The Stroop colour word task is a cognitive computer-based task during which four colour names (blue, green, yellow, and red), coloured differently (i.e., the word "blue" could be randomly displayed coloured in blue, green, yellow or red), are displayed in random sequence. The participant must correctly indicate the colour of the displayed word as fast as possible by pressing the computer's keyboard keys B, G, Y, and R (for blue, green, yellow and red, respectively). After each selection, the program gives visual feedback indicating the correctness of the answer (i.e., the word "red" is displayed in green. In this case the keyboard key G has to be pressed). Immediately after the visual feedback, a pause of 1.5 s is expected before the next colour name. During the familiarization, the participants performed a version of the test with a reduced time (10 min). The task was performed in a silent and quiet room.

2.2.4. *Neutral stimulus*

The neutral stimulus (NS) was administrated in a controlled, quiet, silent room. The participants are required to sit and watch a historical documentary on "History Channel" about the Siberian railways. The documentary lasted 60 min, as in the MF (Staiano et al. 2019).

2.2.5. *Italian mood state questionnaire*

The Italian mood state questionnaire (ITAMS) is the Italian version of Brunel's mood state questionnaire and aims to assess the participants' mood state (Quartiroli, Terry, and Fogarty 2017). It requires compiling a list of 24 questions with a Likert scale ranging from 0 ("not at all") to 4 ("extremely"), indicating the mood status of the moment. The total score (the sum of scores of all items) and the Total Mood Disturbance (TMD, calculated as follows: TMD = depression + tension + anger + fatigue + confusion +100 – vigor) are computed to completely evaluate the mood status of the participants (Mashiko et al., 2004; Annesi, 2005).

2.2.6. Nasa TLX

The Nasa TLX is an evaluative instrument of the workload referred to a specified task (Hart and Staveland 1988). The questionnaire evaluates six items: mental demand, physical demand, temporal demand, effort, performance and frustration. Every item is described in an informative schedule given to the participant during the compilation of the questionnaire as a reminder. In the first part of the questionnaire, the six items are paired in all possible combinations (e.g., frustration vs. effort, temporal demand vs. performance). Participants must choose and circle the item which better describes the task (the MF or the NS) for each of the paired items proposed. The evaluator then records the recurrence of each item (weight). In the second part of the questionnaire, each item is proposed with a visual scale divided into 20 segments representing the workload, from "very low" to "very high." For each of the six items, participants are requested to mark the position that better addresses the perceived specific load. The evaluator records the values given to each item (raw ratings). Subsequently, an adjusted rating (AR) is calculated for each item: AR = weight * raw rating. Finally, the overall workload is assessed using the formula: Overall workload = (Σ AR)/15.

2.2.7. Cubo Fitness Test

The Cubo Fitness Test (CFT) is an evaluation instrument of motor efficiency (Invernizzi et al. 2021, 2022) composed of 5 submaximal tests performed on multiple functions cube-shaped modular tool: the Ruffier's test (RUT), the 30s push-up test (PUT), the 30s sit-up test (SUT), the shoulder mobility test (SMT) and the chair sit and reach test (SRT). RUT measures cardiorespiratory fitness, the PUT and the SUT muscular fitness, while the SMT and the SRT flexibility. All the tests are executed at moderate perceived intensity and evaluated with perception scales such as the adapted Borg's CR-10 scale (Rikli and Jones 2013) or the Stretching Intensity Scale (Freitas et al. 2015) specifically developed for the stretching exercises. The Borg's CR-10 scale has been used to evaluate RUT, PUT and SUT while SMT and SRT (which assess the flexibility fitness) has been evaluated with the Stretching Intensity Scale. At the end of the test battery, a final index of motor efficiency (IME) is calculated. The entire protocol of the CFT has been widely described in previous publications (Invernizzi et al. 2021, 2022).

2.3. Data analysis

The Shapiro–Wilk test was performed with skewness and Kusrtosis analysis to assess the normal distribution of the data. The ANOVA 2×2 analysis (time × group) was performed to evaluate the difference between pre- and post- the two experimental stimuli (MF and NS) in the total score and the TMD of the ITAMS questionnaire. The effect sizes for the ANOVA 2 × 2 were calculated as partial eta squared (η^2_p), using the small = 0.02, medium = 0.13 and large = 0.26 interpretation for effect size. The T-test for dependent means was performed to investigate the differences in CFT performance after the two stimuli (MF and NS) while, to analyze the Nasa TLX data, was used the Wilcoxon test due to a violation of the normal distribution of data. In all tests, the significance level was set at α = 0.05. The effect size for the T-test was assessed using Cohen's d. The interpretation of the effect size was performed using the following cut-off: 0.2 = "small" effect size, 0.5 = "medium" effect size and 0.8 = "large" effect size.

2.4. Results study 1

The IPAQ confirmed that students recruited were sedentary, with a weekly amount of 532.6 ± 58.4 METs. The results of ITAMS' total score and TMD at pre-stimulus did not show any significant difference between conditions (ITAMS total score: p = 0.476, Confidence interval: lower = −0.632, upper = 1.30; TMD: p = 0.077, Confidence Interval: lower = −1.30, upper = 0.074). The analysis of the total score of the ITAMS questionnaire (Figure 1A) evidence a tendency to significance in the interaction (F = 4.384, p = 0.052, η^2_p = 0.205) and a significant time effect (F = 45.291, p < 0.0001, η^2_p = 0.727) while no group effect was highlighted (F = 3.728, p = 0.070, η^2_p = 0.180). Concerning TMD (Figure 1B), the MF resulted in more impactful for participants' moods as evidenced by the significant interaction (F = 7.960, p = 0.012, η^2_p = 0.319) and a significant time effect (F = 7.020, p = 0.017, η^2_p = 0.292).

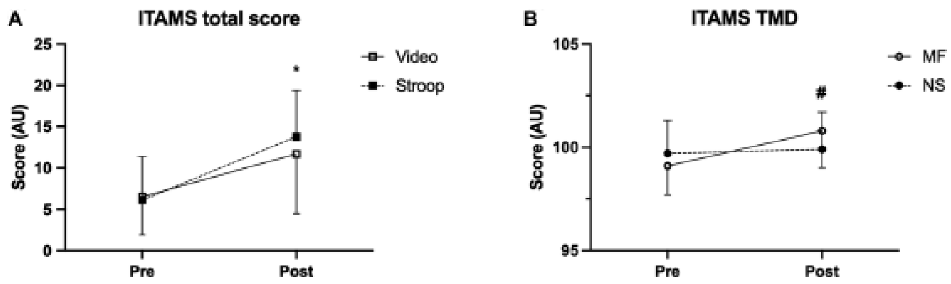

FIGURE 1
ITAMS questionnaire outcomes: interactions of the ITAMS total scores (panel **A**) and ITAMS Total mood disturbance scores (panel **B**). Data are expressed as arbitrary unit (au). NS – neutral stimulus, MF – mental fatigue stimulus. * – time effect (*p* < 0.05). # – significant interaction (*p* < 0.05).

Considering the Nasa TLX results (Table 2), differences between MF and NS were found in "Temporal Demand" (p = 0.036; d = −0.77 moderate) and in "Frustration" (p = 0.001; d = 0.41 small). No differences between MF and NS were detected in CFT outcomes (Table 3).

Table 2. Results of Nasa TLX questionnaire.

Items	MF	NS	*p*-value	Cohen's d
Mental demand (au)	59.6 ± 23.7	51.3 ± 24.4	0.157	−0.35
Physical demand (au)	2.5 ± 7.4	3.6 ± 6.9	0.601	0.15
Temporal demand (au)	32.1 ± 22.9*	15.9 ± 18.8	0.036	−0.77
Performance (au)	21.2 ± 18.1	15.1 ± 19.2	0.181	−0.33
Effort (au)	46.2 ± 21.2	38.1 ± 22.6	0.158	−0.37
Frustration (au)	30.5 ± 28.8*	42.1 ± 28.4	0.001	0.41
Weighted sum (au)	12.8 ± 1.2	11.3 ± 2.0	0.349	−0.91

Results are expressed as mean ± standard deviation. *Difference between mental fatigue (MF) and neutral (NS) stimuli, p < 0.05.

Table 3 Cubo Fitness Test (CFT) performance after Mental fatigue and Neutral stimuli.

CFT tests	MF	NS	*p*-value	Cohen's d
Ruffier's test (au)	24.2 ± 7.0	25.3 ± 7.8	0.276	0.15
30s Push-up Test (au)	8.7 ± 4.5	8.1 ± 4.2	0.311	−0.14
30s Seated sit-up test (au)	11.5 ± 4.7	12.0 ± 4.4	0.376	0.11
Shoulder mobility (cm)	49.0 ± 7.2	48.8 ± 8.2	0.692	−0.13
Chair sit and reach (cm)	0.1 ± 10.3	−0.2 ± 9.8	0.691	−0.03
Index of motor efficiency (au)	51.7 ± 13.5	52.0 ± 13.5	0.789	0.02

Au = arbitrary unit. The confidence intervals (95%) are referred to the difference between Mental fatigue (MF) and Neutral (NS) stimuli.

2.5. Summary of study 1

Individual CFT performance do not differ after receiving mental fatiguing or neutral stimuli before testing. We can assume that CFT does not present internal responsiveness to mental fatigue.

3. Study 2

Study 2 aims to examine at which intensity of perceived exertion (weak, moderate, strong, or absolute maximum) the CFT presents the higher relative reliability for external (performance) and internal (perceived exertion) loads. CFT was performed twice at different intensities of perceived exertion. At the end of the performance, the CFT's workload characteristics were evaluated through the Nasa TLX questionnaire surveyed after testing

3.1. Methods of study 2

Twenty-four (weight: 69.0 ± 8.6 Kg; height: 172.7 ± 10.0 cm; BMI: 23.1 ± 2.1 kg/m^2) sedentary university students of 20.7 ± 1.7 years old were recruited for the second study (16 males and eight females). None of the participants took part in study 1. Inclusion criteria were belonging to sedentary university students who spent at least 7 h/day studying or attending university lessons. Students practicing regular sports or physical activity during free time were excluded. The main analysis performed in study 2 is based on the Intraclass correlation coefficient (ICC; Liaw et al. 2008). Hence, the sample size and the expected number of repeated measures can be considered reliable with an ICC minimum value of 0.6 (Bujang and Baharum 2017). As for study 1, study 2 was conducted in accordance with the declaration of Helsinki and was approved by the ethics committee of the University of Milan (14 September 2020, number 84/20).

3.2. Procedure

Participants were recruited after administering the IPAQ questionnaire. The CFT was executed in different modalities, which were specifically differentiated by requiring participants to perform at intensities corresponding to the weak, moderate, strong, or absolute maximum verbal anchors of Borg's CR-10 scale of perceived exertion. Consequently, the CFT protocol was modified to fit with the different modalities proposed, as follows:

3.2.1. Cardiorespiratory fitness (CRF)

The cardiorespiratory fitness test is an adaptation of the Ruffier test. Participants were required to sit and stand from the sitting part of the cube with a self-paced rhythm reaching the required perceived exertion (weak, moderate, strong, or absolute maximum on Borg's CR-10 scale) in 45 s. Every 10 s the evaluator gives feedback about the elapsed time to permit the participant to adapt the rhythm to better address the effort.

3.2.2. Muscular fitness

For each of the two tests (PUT = 30s push-up and SUT = 30s seated sit-up), participants had 30 s to reach the required perceived exertion (weak, moderate, strong, or absolute maximum on Borg's CR-10 scale), choosing from the three possible difficulty levels as described in Study 1.

3.2.3. Flexibility fitness

Participants were asked to stretch for each test (SMT = shoulder mobility and SRT = chair sit and reach), performing an effort comparable to the required perceived exertion (weak, moderate, strong, or absolute maximum on Borg's CR-10 scale). For study 2, to determine the stretching intensity, the Borg's CR-10 scale was used instead of the SIS scale. This choice was made in order to equalize the intensity of flexibility tests to the cardiorespiratory and muscular fitness tests (weak, moderate, strong, and absolute maximum; Laur et al. 2003; López-de-Celis et al. 2022). Before the beginning of the experiment, participants accomplished 3 days of familiarization with the perception scales and CFT. Successively, the participants performed the CFT twice (test and retest) at each intensity (weak, moderate, strong, or absolute maximum; Liaw et al. 2008). The necessary eight testing days to complete all measurements were distanced 1 week, one from another. The test calendar (comprising the order of the intensities proposed on the different days) was randomized using the site www.randomization. com to avoid unwanted side effects caused by the sequence of the perceived exertions. During each test day, before the CFT, participants were requested to express the value which better addressed their psychophysical recovery with the TQR scale (values up to 13 were considered adequate to let the participants begin the test session) and then to perform the CFT test at the programmed modality. To better understand the characteristics of the proposed workload, at the end of each test session, participants estimated their tasks with the Nasa TLX.

3.3. Data analysis

The test–retest reliability of the CFT proposed at different perceived exertion was investigated using the Intraclass correlation coefficient (ICC; Liaw et al. 2008). The ICC was assessed for the test performance (CFT performance values) and the perceived exertion values provided by participants (RPE perception values). Given the sample size of Study 2 and the number of measurements performed, the ICC values higher than 0.6 with a value of p lower than 0.05 were considered reliable (Bujang and Baharum 2017). Moreover, the One-Way analysis of variance (ANOVA) was performed to verify the differences in workload (Nasa TLX), intensities perceived and CFT results at different modalities, using the mean obtained with the values of test and retest measures. The post-hoc test was performed with the Bonferroni correction. An $\alpha = 0.05$ was considered for this analysis.

3.4. Results of study 2

The IPAQ confirmed that students recruited were sedentary, with a weekly amount of 628.4 ± 58.4 METs. The CFT performances were found reliable in all the modalities proposed except for the weak modality in CRF and in the Index of Motor Efficiency (IME), and for the absolute maximum modality in CRF (Table 4). The values of RPE perceptions given by participants were found to be reliable in all CFT tests proposed at moderate and strong modalities, while the weak and absolute maximum modalities did not meet the reliability for any of the CFT tests. All RPE ICC values are reported in Table 4. Test–retest detailed results of CFT performances and of RPE perceptions are provided in Supplementary Table 1. The one-way ANOVA analysis showed differences in the CFT tests' performances for most of the modalities proposed, while no differences were detected in strong and absolute maximum modalities in the CRF, SUT, SMT, SRT and IME tests (RUT: $p = 1.000$; SUT: $p = 0.051$; SMT: $p = 1.000$; SRT: $p = 1.000$). Moreover, a similarity between the results of weak and moderate modalities was found in RUT ($p = 1.000$), SMT ($p = 0.119$) and SRT ($p = 0.080$). A similarity between the results of moderate and strong modalities was found only for SMT (p = 0.253) and SRT (p = 0.725.) The RPE perception values differed for each modality considered ($p < 0.05$). The mean Test results and mean perception values of each modality are reported in Supplementary Table 2. The one-way ANOVA analysis performed on the overall workload of the Nasa TLX outlined significant differences. The post hoc test outlined that the weak modality was different from the strong and absolute maximum modalities, while the absolute maximum modality differed from moderate (Figure 2). The complete results of the Nasa TLX are reported in Figure 2.

Table 4. Intraclass Correlation Coefficient (ICC) of the CFT (performance) and RPE (perception) results at different intensities.

	Modalities	CRF	PUT	SUT	SMT	SRT	IME
CFT (performance results)	Weak	0.014	0.876*	0.808*	0.960*	0.909*	0.147
	Moderate	0.805*	0.944*	0.823*	0.943*	0.838*	0.655*
	Strong	0.810*	0.944*	0.852*	0.984*	0.939*	0.518*
	Absolute maximum	0.413	0.955*	0.755*	0.985*	0.919*	0.843*
RPE (perception results)	Weak	−0.603	−0.852	−0.793	0.093	−0.28	−0.433
	Moderate	0.642*	0.737*	0.740*	0.690*	0.723*	0.831*
	Strong	0.810*	0.765*	0.758*	0.788*	0.846*	0.822*
	Absolute maximum	−0.459	−0.105	0.405	−0.018	−0.111	0.423

Data refers to ICC r values. CFT = Cubo Fitness Test, RPE = Rate of perceived exertion by CR-10 Borg's scale. CRF = cardiorespiratory fitness, PUT = 30s push up test, SUT = 30s seated sit up test, SMT = shoulder mobility test, SRT = seated sit and reach test, IME = index of motor efficiency. *$p < 0.05$.

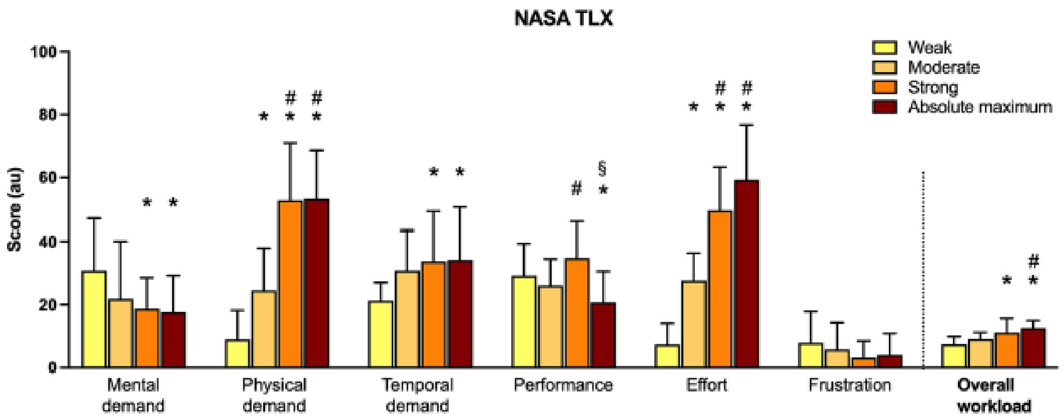

FIGURE 2
NASA TLX outcomes of domains (Mental demand, Physical demand, Temporal demand, Performance, Effort, and Frustration) and Overall Workload. Significant differences: * – against *weak* ($p < 0.05$), # – against *moderate* ($p < 0.05$), § – against *strong* ($p < 0.05$).

3.5. Summary of study 2

CFT performance values present relative reliability at different intensities except in CRF and IME domains when performed at weak intensity and in the CRF domain at absolute maximum intensity. In this analysis, moderate and strong modalities present reliability in all tests performed. The RPE perception values are reliable in all CFT domains proposed at moderate and strong modalities. The overall workload from Nasa-TLX showed significant differences. The weak modality differs from strong and absolute maximum modalities and absolute maximum from moderate.

4. Discussion

This study investigated the internal responsiveness stating that the CFT must not be influenced by acute mental fatigue to be a valid instrument for assessing motor efficiency (study 1). Moreover, this study explored which intensity of perceived exertion among weak, moderate, strong, and absolute maximum could be more appropriate to submit the CFT to a population of sedentary university students (study 2).

4.1. Study 1

Results evidenced that the two stimuli proposed had a different impact on participants. Concerning the ITAMS (mood evaluation) total scores, both MF and NS reported a worsening in the mood state. Nevertheless, considering the total mood disturbance results, MF reported a significant variation differently than NS, which reported a significantly lower alteration (close to 0). Noticeably, Nasa TLX (task's workload) suggested that a temporal demanding load characterizes MF, while NS is a more frustrating task for the participants. Understanding whether mental fatigue is correctly induced represents a significant challenge. In the study of Pageaux et al. (Pageaux et al. 2014), no mood alteration caused by the intervention was found, while with Nasa TLX, a significant increase in mental demand and effort was observed. In another similar study by Staiano et al. (Staiano et al. 2019), the BRUMS (mood evaluation) and Nasa TLX questionnaires were employed to evaluate the effect of mental fatigue on time trial kayak training. Like our protocol, they proposed two stimuli (mental fatigue stimulus with the Stroop colour word task and neutral stimulus with a documentary), showing mood alteration and a higher workload after the mental fatigue stimulus compared with the neutral. In both studies (Pageaux et al. 2014; Staiano et al. 2019), the results were considered adequate to define participants as mentally fatigued. Indeed, the increasing total mood disturbance and perceived workload seem related to mental fatigue, which is defined as a "psychobiological state caused by prolonged exposure to a challenging cognitive activity, where the subject experience feeling of tiredness and lack of energy" (Marcora et al. 2009). Given that, we point out that the participants of the study 1 experienced a worsening of their mood along with an increased perceived workload after MF, probably determining a mental fatigue status (Marcora et al. 2009; Pageaux et al. 2014; Staiano et al. 2019). However, despite the mental fatigue, CFT did not report a significant difference from the neutral condition. It follows that the MF did not alter CFT. This seems different from what is highlighted by literature (Van Cutsem et al. 2017; Grgic et al. 2022; Marcora et al. 2009; Pageaux et al. 2014; Smith et al. 2016), which stated that mental fatigue could have an impact on perceived effort and performance (Trecroci et al. 2020). A possible explanation could be found in the CFT characteristics. The physical tasks requested by the CFT have a short duration and a submaximal intensity (perceived as moderate). Factors such as duration and intensity of the physical task seem relevant when the influence of mental fatigue on performance is considered. The review by Van Cutsem et al. (Van Cutsem et al. 2017) reported that mental fatigue typically influences prolonged efforts while not affecting tasks of short duration, such as high-intensity exercises, power and anaerobic performances. Only a few studies reported an absence of mental fatigue influence on physical performance. Martin et al. (Martin et al. 2016) asserts that a higher inhibition capacity and resistance to mental fatigue induced by training, as in professional athletes, could reduce the influence of mental fatigue on performance. However, the participants of this study were not professional athletes. According to Van Cutsem et al. (Van Cutsem et al. 2017), high expertise and inefficient mental stimulus are possible causes for the lack of influence of mental fatigue on performance. As previously seen, we can exclude the inefficiency of the protocol in inducing mental fatigue. Hence, from the results reported by the literature, we could associate the lack of difference in CFT after a mental fatigue stimulus with the reduced time of effort (never more than 45 s), the low intensity of the proposed stimulus and the good familiarization of the participants with the proposed tests. The obtained results are of particular interest for the CFT validation. Indeed, this test is strictly related to perceived exertion, and acute mental fatigue is demonstrated to influence effort perception, increasing it significantly (Van Cutsem et al. 2017; Marcora et al. 2009; Smith et al. 2016). The ability of CFT to withstand mental fatigue can be a significant advantage for testing, mainly when implemented in university and desk-working environments. These environments often involve constant daily exposure to mentally draining stimuli (Mainsbridge et al. 2020). University students and desk workers perform in conditions of high temporal demand and, in some cases, can develop study and work-related frustration. All these conditions would not interfere with the CFT outcomes, giving an actual measure of the psychophysical status, even in those individuals already mentally exhausted (e.g., after or during intense studying and working days). The CFT aims to evaluate a wide range of sedentary populations also for being used even in universities or in working contexts as a fundamental element of the UP150 project (Invernizzi et al. 2021, 2022; Signorini et al. 2022). Having a submaximal test based on effort perception could represent an advantageous method to evaluate the motor efficiency of the students and workers regularly. The presence of an adequate evaluation in these populations could motivate improving psychophysical status with the help of structured intervention as for the UP150 project (Invernizzi et al. 2021, 2022; Signorini et al. 2022) and active pauses for desk workers and students, respectively (Keating et al. 2022).

4.2. Study 2

The aim of study 2 was to investigate which intensity modality to perform could present higher reliability (in CFT performance and RPE perception values) and be more adequate for the CFT protocol in a population of sedentary students.

4.2.1. CFT performance

Of note, the index of motor efficiency was not reliable only at the weak modality of the CFT. This result is influenced by the values obtained in the CRF, which did not meet the reliability at the weak and absolute maximum modalities of the CFT. However, the other four sub-tests (SUP, SUT, SMT and SRT) were reliable. From these results, we can assert that the most reliable results were moderate and strong, as also confirmed by previous studies (Invernizzi et al. 2021, 2022). These results are influenced by the cardiorespiratory test proposed. Indeed, this is the only test of the CFT that was not found reliable in the weak and absolute maximum modalities. This could be due to the nature of the test, which is based on the measure of the Heart Rate (HR) and a self-pace execution differently from other submaximal cardiorespiratory measurements, which provide a guided execution based on rhythm, power or rates per minute in CFT (Wang, Su, and Celler 2006). Both the CFT modalities considered (weak and absolute maximum) referred to widely known and embodied experiences (Bloomfield and Dale 2015; Borg 1982). Indeed, in common experience, people have more familiarities and clear-cut ideas of their maximal and minimum potentialities, while the shades are more poorly defined (Borg 1990). A clearer idea of the target to reach (minimum or maximum effort) could influence the rhythmic execution of the test. Participants, indeed, are free to increase or decrease the intensity of the exercise to fit more precisely with the intensity requested (the evaluator gave feedback about the time every 10 s). The different intensity execution could have impacted HR, changing according to the exercise rhythm and affecting the final rate related to the intensity portrayed in the last seconds. Hence, the reliability of the weak and absolute maximum CFT modalities could have been impaired. It is interesting to notice that the trend of reliability of results in cardiorespiratory fitness results is similar to what found in all perceived exertion (that will be better explained in the following paragraphs), highlighting a link between perceived exertion and HR as expressed in literature (Borg 1982).

4.2.2. CFT's RPE perception

As evidenced by statistical analysis, participants reported significant differences between each modality of the CFT experienced considering perceived exertion. Most of the given values coincided with the requested perception, demonstrating a good participants' comprehension of the instructions the evaluator gave (except for absolute maximum, which resulted in lower than requested). Nevertheless, not all the intensities were found reliable. It could indicate that some intensities of effort could be more affordable to be perceived or reached than others. More specifically, the intensities moderate and strong seem easier to reach and perceive and are more reliable. It could have several explanations. Different authors stated that the weak perceived exertion, even if commonly experienced, could be more difficult to discriminate precisely and is more influenced by psychological factors than physiological ones due to fewer changes induced by physical exercise, which impede the reaching of an adequate stimulus perception threshold (O'Sullivan 1984; Razon et al. 2012; Rejesky 1981). Moreover, absolute maximum perceived exertion could be harder to reach, possibly due to the reduced time of the tests, which could be inadequate to reach a maximal effort for the most trained participants (Swart et al. 2009). Indeed, as explained in the methodology section, most of the CFT protocol tests had a time of execution of 45 s or lower, which resulted inadequate for the most trained participant. A different explanation arises from the flexibility fitness tests (SMT and SRT) of the CFT; indeed, these tests did not present a time of execution. The lack of reliability of weak and absolute maximum modalities could find an explanation for the daily variability of muscular tone which could depend on the activity made the day before the test and on the emotive status (Masi and Hannon 2008; Wahlström et al. 2003). Considering the perceptive nature of the test, a variation of the basal muscular tone could influence the perception of what is "easy" and what is "difficult" to reach, varying the perceptive outcomes. Furthermore, in the weak modality, the participants were asked to perform a light effort that could result in too low to reach an adequate stimulation threshold of the proprioceptive receptors (like muscles spindles, the Golgi tendon organs or skin and connective tissue receptors; Halata 1988) to precisely discriminate the physical perceptions (Refshauge et al. 1995). Consequently, this lack of precision could have influenced the obtained results. Concerning the absolute maximum CFT modality, the high effort that went into the stretch of the muscles highly involved the pain mechanism, probably activating the stretch reflex differently (Matre et al. 1998). The activation or non-activation of this typology of reflex could change the muscular tone, which makes it easier or more difficult to reach maximal stretching perception (Matthews 1991) due to the augmented muscular tone. This phenomenon could consequently increase the effort to reach individual standards (Jones 1995). Hence, the increased difficulty could result in a higher effort perceived, widening the variability between the two perception measures, possibly caused even by an altered mood state (Berger et al. 2016).

4.2.3. NASA TLX outcomes

As previously highlighted, the Nasa TLX analysis seems to support the higher reliability of moderate and strong CFT modalities. Lower perceived intensity of CFT modalities determined higher mental demand and lower physical demand in Nasa TLX. This is not surprising, as lower exertion intensities have a lower impact on physical effort and consequently on physiological changes effort induced. Hence, due to this low perturbance of physiological status, this type of effort requires more cognitive activity to perceive the intensity (O'Sullivan 1984). Furthermore, the Nasa TLX outcomes could explain even the poor reliability of the absolute maximum CFT modality. Analyzing the absolute maximum modality outcomes of the Nasa TLX, few differences with strong are reported, similar to CFT outcomes (see paragraph 4.2.1). Hence, from the participant's point of view, the load characteristics of the two modalities were similar. The "physical demand" variable did not report significant differences, evidencing that the required physical effort to reach the target did not differ between the two modalities (they were both very high). In the same way, the variable "effort" (which describes the difficulty of reaching the given task) evidences a similarity between them. At least, "temporal demand," as in the previous variables, shows similar characteristics for strong and absolute maximum modalities. A similar "temporal demand" (which describe the grade of temporal pressure given by the task) could indicate an inadequacy of the test in raising the physical request from strong to absolute maximum intensity, as the participant were not able to detect a difference between the two stimuli proposed (Pöppel 1997). The variable "performance" (which describes the grade of satisfaction of the participants about how they performed) gives another interesting insight. Indeed, at the absolute maximum modality, participants reported a significative lower level of performance compared with the strong modality, indicating a sort of failure in reaching the given instructions (indeed, the perceived exertion reported at the absolute maximum modality was lower than 9 (au) as seen in Supplementary materials 1, 2; Lowndes et al. 2020). Analyzing the overall workload measured with the Nasa TLX, it seems to increase gradually with the intensity proposed. Moderate and strong have similar characteristics, while weak and absolute maximum are opposite. Results from Figure 2 suggest three workload levels in performing CFT: a low level corresponding to weak and moderate modalities, an intermediate level corresponding to moderate and strong modalities, and a high load level corresponding to strong and the absolute maximum modalities. In brief, the CFT performance were found reliable for each CFT test only at the moderate and strong modalities. Similarly, the most reliable RPE perception values were found at moderate and strong modalities. Finally, the CFT at different intensities could be characterized by three macro load levels identified by the Nasa TLX: the intermediate level is composed of moderate and strong CFT modalities. Considering the health purpose of the test, it could be asserted that the intensity which better addresses the CFT is the moderate version, as proposed in the original protocol. Even if the strong modality could constitute a valid alternative modality, the choice of a conservative modality (moderate) makes the test accessible to a broader range of populations, including young to older and sedentary to active people (Pescatello 2014). Of note, for the correct execution of the CFT, a familiarization period based on perceived exertion scales is needed (Razon et al. 2012). The present study indicates that the moderate and strong efforts are easier to be interpreted than weak and absolute maximum, facilitating the perceiving approach to those individuals not accustomed to perceived exertion scales. The perceived exertion could represent a valid tool both for evaluation and education. Teaching how to perceive could educate people to manage their bodies and adequately use physical exercise for health. Furthermore, educating on good practices and the proper use of the body increase autonomy and the sense of competence, which could bring positive transfer to people's life as a result of the increasing motivation, as evidenced in many motivational theories (Deci and Ryan 2000; Lakerveld et al. 2012). The gender proportion could represent a limitation of the present study. Indeed, in both studies, the male/female ratio was unbalanced in favour of males. Moreover, the absence in the literature of effective methods that can determine with precision if and how mental fatigue affects participants could make it hard to understand the efficacy of the methodology in administering mental fatigue. Indeed, it cannot be excluded that an extremely cognitively demanding whole-day activity may be able to alter the results of CFT (due to a higher amount of mental fatigue).

5. Conclusions

Our study seems to evidence that CFT does not present an internal responsiveness to cognitive load, confirming that it could not be affected by acute mental fatigue. Furthermore, our study indicates that

CFT presents relative reliability only for moderate and strong intensities. Anyway, an initial familiarization period on all level of intensities before testing is essential to favour a more adherent comprehension of the perceived exertion as suggested by literature.

5.1. Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2023.1254767/full#supplementary-material

Analysis and exploration C (*Step 3*)

Step 1 set the basis of the UP150 concept and investigated CFT validities together with *Step 2*. To better apply the UP150 concept to a real working context, an investigation of the effect of working modality (on-site and hybrid work) on workers' psychophysical health is necessary. Hence, *Step 3* followed this direction.

Hybrid and on-site working: correlation between working modality and psychophysical health

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Abstract

BACKGROUND: This study investigates the psychophysical health implications of hybrid and on-site working modalities among desk workers. It focuses on how hybrid work, integrating remote and on-site elements, influences physical activity, efficiency, and overall health.

METHODS: The research involved 57 desk workers, evaluated using the International Physical Activity Questionnaire and accelerometers for physical activity, the Cubo Fitness Test for physical efficiency, and blood sample analyses for clinical parameters. Psychosocial traits were assessed through the General Self-Efficacy Scale, the Psychological General Well-being Index, and the Job Content Questionnaire. We analyzed: i) the correlation between physical activity, physical efficiency, and health parameters in the entire sample of desk workers (composed both by hybrid and on-site workers), ii) differences between hybrid and on-site workers, iii) correlations between hybrid work composition (the percentage of remote working per week) and health-related parameters.

RESULTS: Statistical analysis showed relationships between physical efficiency, amount of physical activity, and clinical health parameters in line with the literature. Moreover, hybrid workers engaged in significantly more intense physical activities outside work hours than on-site workers. In addition, hybrid working showed better results in some components of psychosocial well-being. Despite that, no significant differences were found in clinical health parameters. A correlation analysis between hybrid work composition and all considered health-related parameters highlighted that the higher the remote working, the higher the vigorous physical activity, but the worse the psychosocial status and clinical parameters.

CONCLUSIONS: The findings suggest that a hybrid working model could effectively support the health of desk workers if adequately balanced.

Key words: Remote working; Job perception; Physical activity; Sedentarism; Self-efficacy

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1. Introduction

Hybrid working is an emerging work mode that combines an on-site job in the usual workplace and a remote job, generally at home. It has been further boosted as an alternative working habit following the SARS-CoV-2 pandemic, during which forced work-from-home was broadly experienced worldwide, nowadays becoming a new form of remote working (Williamson et al. 2022).

The recent literature addresses remote working (or work-from-home, telework, or smart working) as a flexible work method. It allows employees to perform their tasks outside the traditional office environment, an increasingly prevailing approach in various professional landscapes (Aksoy et al. 2023). Indeed, even before the pandemic, this practice gained popularity thanks to technological advances that allow communication and collaboration without the need to be physically present in a specific place (Messenger and Gschwind 2016). It further evolved into a new normal in many professional figures who, for tasks, are not necessarily forced to a job in presence (Aksoy et al. 2023). Working from home is well appreciated by professionals, who positively consider the subsequent reduction in commuting costs, stress, and increased flexibility (Ferreira et al. 2021). In particular, flexibility allows the workers to manage better and schedule more efficient work and spare time, reducing the stress generated by rigid on-site working hours restrictions and adapting the day based on personal and professional needs. As a result, working from home generally increases employees' job-related positive well-being and life satisfaction (Anderson, Kaplan, and Vega 2014; Kondratowicz et al. 2021).

Despite these advantages, some physical and psychological impacts can be outlined when working away from the on-site workplace. Among them, the adverse effects of increased sedentary lifestyles are the main relevant: working from home often involves long hours of sitting (Wells et al. 2023), higher than when working in the office. This lack of physical activity may affect health issues, such as back pain, weight gain, and decreased overall well-being, which desk workers commonly experience (Blair 2009) and represents additional raising risks for health and well-being. Another consequence of increased sedentary activity while working from home is screen fatigue (Wells et al. 2023): screen exposure increases for work or virtual meetings, possibly ending with Computer Vision Syndrome (Gowrisankaran and Sheedy 2015). Working from home also implies that employees may experience psychological discomfort, leading to isolation and loneliness, as employees miss out on the social interactions of a traditional office environment (Becker et al. 2022).

A somewhat controversial aspect is work-life balance, specifically achieving satisfactory work functioning at home without conflicts with leisure time. Indeed, while working from home potentially allows better work and spare time scheduling thanks to the increased flexibility (Ferreira et al. 2021), it may also produce adverse conditions where the boundary between work and personal life can blur. Without a clear separation, employees may find it challenging to switch off from work, causing them to work harder and longer, even sometimes when sick, negatively affecting their work-life balance (Felstead and Henseke 2017).

Hybrid working, allowing flexible composition of remote and on-site work, can improve work-life balance and increase job satisfaction and overall well-being (Bloom, Han, and Liang 2022). Hybrid working also enables customization based on the nature of different roles, supporting collaboration in the office when needed and working from home for focused tasks. Finally, it can positively impact employees' and employers' engagement, productivity, and cost savings (Zapata-Cantú 2022). From the employers' side, hybrid working enhances talent acquisition and retention by making a company more appealing to individuals who value flexible work arrangements (Selvi and Vandana 2023). Hence, hybrid working could represent a valuable modality to integrate the advantages of both from-home and on-site work, reducing specific adverse effects.

To plan more successful policies and procedures supporting the new needs of modern working habits, it is necessary to thoroughly investigate the hybrid working mode composition (work from home and on-site) and its relationships to individual physical, mental, and social well-being. Specifically, this study on desk workers aimed to investigate: i) relationships between physical efficiency, weekly physical activity, and health (clinical parameters); ii) workers' differences in physical, psychosocial, psychophysical, and health status based on working habits (hybrid or entirely on-site); iii) relationships between hybrid work composition (the percentage of remote working per week) and physical, psychosocial, psychophysical, and health features.

2. Methods

2.1. Participants

Fifty-seven desk workers, whose demographics are provided in Table 1, volunteered to participate in this cross-sectional research. They had to meet the following criteria for inclusion: i) have an office job; ii) have a working week with at least 6 hours of daily sedentary work; iii) be in good health and without conditions that could limit physical activity. All participants received a comprehensive explanation of the study procedures and potential risks. Subsequently, they signed informed consent forms, acknowledging their right to withdraw from the study at any point. The study adhered to the principles of the Declaration of Helsinki and obtained approval from the local University Ethics Committee (protocol code 101/22 – 05.12.22).

The ordinary participants' working habits, namely the number of working days and hours spent regularly in remote (at home) or on-site working, were surveyed to categorize them as hybrid and on-site workers to compare and correlate working patterns with physical, health, and psychological profiles. To be categorized as a hybrid worker for this study, at least four hours per week must have been spent working remotely at home.

Table 1. Participants' demographics.

	Hybrid workers	**On-site workers**	**Overall**
N (%)	25 (45%)	31 (55%)	56 (100%)
Female workers (%)	12 (48%)	18 (58%)	30 (54%)
Male workers (%)	13 (52%)	13 (42%)	26 (46%)
Age (years)	40.7 ± 11.3	40.3 ± 12.5	40.5 ± 11.8
BMI (kg/m^2)	23.6 ± 3.1	22.3 ± 3.4	22.9 ± 3.3
Weekly working hours	41.1 ± 6.2	41.5 ± 5.2	41.3 ± 5.6
Weekly hours in remote work	10.8 ± 7.8	0	4.8 ± 7.5
Weekly days in remote work	1.5 ± 1.0	0	0.7 ± 1.0
Weekly remote working (%)	27.6 ± 21.4	0	12.3 ± 19.8

Weekly remote working is the mean of individual percentages of remote working to the corresponding weekly working hours.

As detailed below, participants underwent a submaximal-effort-based battery test to assess physical efficiency, blood samples to assess clinical parameters, and several surveys to assess psychological traits and any other information to complete profiling or integrate direct measurements.

2.2. Physical status evaluation

2.2.1. Physical efficiency

The Cubo Fitness Test (CFT) evaluated employees' physical fitness levels. The CFT is a cube-shaped multifunctional apparatus integrating five submaximal tests based on effort and pain perception that has demonstrated sensitivity in assessing cardiorespiratory, muscular, and flexibility fitness (Invernizzi et al. 2021). Testing execution must be maintained at an effort perception corresponding to moderate according to Borg's CR-10 scale in cardiorespiratory and muscular measurements and a pain perception corresponding to no pain (level 100) according to the SIS scale in flexibility measurements (Invernizzi et al. 2020). This test was chosen as a physical assessment as it presents less risk for health than other maximal tests. Moreover, this test has already been used in literature to assess the physical efficiency of the desk workers population (Invernizzi et al. 2022).

The cardiorespiratory fitness assessment is based on the Ruffier test: Participants sit and stand up on the cube at a frequency of 40 bpm for 30 repetitions (or 45 seconds). Heart rate at the baseline (HR0), immediate post-test (HR1), and one-minute post-test (HR2) time points are collected, and the Ruffier index (RI) is calculated as RI = (HR0 + HR1 + HR2 – 200) / 100. The lower the RI values, the better the performance. Muscular fitness of upper limbs and core muscles is evaluated through the 30-second push-up (PU) and 30-second seated sit-up (SU) tests, respectively. In PU, participants select a CFT setting difficulty (by varying hand support heights) to perform, preserving a moderate effort perception. Similarly, participants regulate the effort in SU by setting their back inclination. Results (repetitions or time) are converted into scores based on effort setting and participant's gender, returning a maximum score of 20 points on both tests. Flexibility is measured by Shoulder Mobility (SM) and the Chair Sit & Reach (S&R) tests. In SM, participants circle their extended upper limbs without losing grip on a graduated stick, while in S&R, they sit on the cube's edge, extending one leg on a graduated board while bending the other, and lean forward to reach or surpass the heel with both hands. The results (in centimeters) are converted into scores based on gender, with the maximum score being 10 points each on both tests.

By summing the scores of the five submaximal tests, an Index of motor efficiency (IME) ranging from 10 to 100 points is returned, representing the overall physical fitness level normalized by age. Scores below 33 are considered low (Level C), 33 to 66 are medium (Level B), and above 66 are high (Level A). CFT's validity and reliability have been previously proved (Invernizzi et al. 2021; Signorini et al. 2023).

2.2.2. Weekly physical activity

The International Physical Activity Questionnaire (IPAQ), a validated questionnaire for adults aged 18 to 65 (Patterson 2010), assessed the weekly physical activity intensity esteem. The questionnaire returns a total score indicating the activity in METs: below 700 METs indicates the respondent is inactive, 700 to 2519 METs active, and above 2519 METs very active. From the questionnaire, it is also possible to discriminate how long each range was held (in minutes).

An additional evaluation of weekly physical activity intensity has been performed using triaxial accelerometers Axivity AX3 (Axivity Ltd., Newcastle upon Tyne, UK), which calculate sedentary, light, moderate, and vigorous physical activities that, according to the literature guidelines, correspond to lower than 1.5, 1.5 to 3, 3 to 6, and higher than 6 METs, respectively (Katzmarzyk and Craig 2002). Accelerometers were worn on the non-dominant wrist from Monday to Monday.

2.3. Psychosocial status evaluation

2.3.1. Self-efficacy

The General Self-Efficacy Scale (GSES) (Schwarzer and Jerusalem 1995) was used to evaluate participants' self-efficacy. The GSES is a widely acknowledged and frequently utilized psychometric tool designed for gauging an individual's perceived self-efficacy and belief in successfully navigating challenging life situations. Comprising ten statements reflecting diverse life scenarios and challenges, from managing stress to overcoming obstacles and achieving goals, the GSES seeks to encapsulate a universal and enduring sense of self-efficacy. It underscores an individual's confidence in performing effectively across various contexts. Elevated scores on the General Self-Efficacy Scale (the total score ranges from 10 to 40) correlate with enhanced psychological well-being, heightened resilience in life stressors, and improved performance in various domains. The scale is commonly applied in research settings and clinical practices to evaluate an individual's perceived self-efficacy, offering insights for designing interventions to fortify this pivotal aspect of psychological functioning.

2.3.2. General well-being

This study used the Psychological General Well-being Index (PGWBI) (Grossi et al. 2005) to assess general well-being. It is a concise questionnaire comprising 22 items delineating individuals' psychological-emotional profiles through six specific scales. It provides a comprehensive assessment of the overall well-being via a unified total index derived from the summation of responses to all questions. It is well-suited for deployment in descriptive studies and as an outcome measure in controlled trials. The scoring system, ranging from 0 to 110 points, facilitates categorizing subjects into four distinct groups based on their stress/well-being levels: severe distress, moderate distress, non-distress, and positive well-being.

2.3.3. Job satisfaction

Perceptions connected to the job were investigated by the Job Content Questionnaire (JCQ) (Karasek et al. 1998), a questionnaire of 49 items widely used in the field of occupational health psychology for measuring psychosocial aspects of the work environment that may impact employees' well-being and health. The JCQ focuses on different dimensions of job characteristics and provides insights into individual job-related experiences, including job demands, job decision latitude control, and social support. Job demands refer to the psychological and emotional pressures associated with the work, job decision latitude control encompasses the degree of autonomy and decision-making authority an individual has, and social support examines the perceived level of support from colleagues and supervisors and the quality of interpersonal relationships.

2.4. Psychophysical status evaluation

2.4.1. Workload

The NASA-TLX tool examined the employees' perceived workload of the preceding workweek. The questionnaire (Hart 2006) evaluates the workload related to specific scales associated with mental demand, physical demand, temporal demand, effort, performance, and frustration. The questionnaire comprises pairwise comparisons of the scales, and the respondent is requested to select the most representative answer within each pair. Based on frequencies, 0 to 5 points for each item (weight) are assigned. The respondent is afterward asked to score each item using a scale with 20 equal intervals, with endpoints labeled as high and low (rating). The assigned scores are converted into a conclusive score ranging from 0 to 100 for each subscale by multiplying weight by rating. Also, a total score summarizes the overall workload.

2.4.2. Recovery status

The employees' perceived recovery status was assessed before the CFT and throughout the working week to ensure the suitability of CFT performance. The Total Quality Recovery Scale (TQR) validated scale (Kenttä and Hassmén 1998) rates the psychophysical recovery in the previous 24 hours on a scale ranging from 6 (very, very poor recovery) to 20 (very, very good recovery). Noticeably, to perform the CFT, participants should be in a reasonable recovery status, with at least a TQR score of 13.

2.5. Health status evaluation

2.5.1. Clinical parameters

Blood samples (22.5 mL) were collected from individuals in a seated position through standard antecubital venipuncture. The samples were promptly placed on ice and preserved until plasma or serum centrifugation at 4°C occurred within 1.5 hours of sampling. Following centrifugation, plasma and serum were frozen at -60°C for subsequent duplicate analysis. Plasma glucose levels were measured using a glucose analyzer from Beckman Instruments, Fullerton, CA, USA. Free insulin levels were determined through a precise two-site monoclonal antibody-based immunosorbent assay (ELISA) provided by Dako Diagnostics, Cambridgeshire, UK. A commercial ELISA kit was employed to assess plasma cortisol levels. Creatinine levels were identified using a Beckman Coulter analyzer. The lipid profile was measured through the immunoenzymatic technique.

2.5.2. Eating habits

The Eating Habits Questionnaire (EHQ) (Gleaves, Graham, and Ambwani 2013) was administered to assess the participant's eating habits and detect deviations in regular eating. The EHQ has been designed to evaluate knowledge, challenges, positive feelings about healthy eating, and thoughts, actions, and emotions possibly associated with an extreme emphasis on healthy eating, such as orthorexia. Specifically, the 21 items of the EHQ are grouped into three subscales: problems, knowledge, and feelings, which return a maximum score of 48, 20, and 16 points, respectively.

2.5.3. Sleep Quality

The Pittsburgh Sleep Quality Index (PSQI) (Curcio et al. 2013) assessed participants' sleep quality. The PSQI is a self-report questionnaire designed to assess sleep grade over one month. Developed by researchers at the University of Pittsburgh, it is widely utilized in clinical and research settings to evaluate various dimensions of sleep. The PSQI includes questions concerning sleep-related aspects such as latency, duration, efficiency, disturbances, medications, and dysfunctions to rate the sleep quality ultimately, measured on a 4-point Likert scale. It is valuable for identifying individuals with sleep problems (higher scores indicate poorer sleep quality) and assessing changes in sleep patterns over time.

2.6. Statistical Analysis

The sample size was calculated using the program G*Power, using 80% statistical power and an estimate of the effect size of 0.7 (Cohen's d). The Student's statistical test for unpaired data was chosen as the study's primary analysis. The sample size resulting was 51 participants.

Data were analized using the IBM SPSS v20 software (IBM, New York, NY, USA). The normal distribution of data was assessed by examining the skewness and kurtosis of data distribution. The equity of variances was investigated using Levene's test. The Welch correction was used in data that did not meet the equal variance assumption. Successively, statistical analysis followed a three steps pathway: i) Pearson's r correlations (or the respective Spearman's rho) on the overall data investigated relationships between weekly physical activity, physical efficiency, and health (between activity by accelerometers, IPAQ, IME, and clinical outcomes); ii) an unpaired t-test (or the respective Mann-Whithney U test) compared the physical, psychosocial, psychophysical, and health status of hybrid and on-site workers, which was defined as absolute comparison; iii) Pearson's correlation (or the respective Spearman's rho) between the percentage of remote work per week and each variable was calculated solely for hybrid workers to observe the effects of work composition, representing the so-called relative comparison. The alpha value was set at 0.05.

3. Results

Several significant correlations were found in the overall sample analysis that considered relationships between physical efficiency, weekly physical activity, and health. IME, that is, the index of motor efficiency resulting from the CFT administration and summarizing the individual physical efficiency, was directly correlated with the total activity measured by accelerometers and IPAQ (r= 0.28, p = 0.04; rho = 0.419, p = 0.04), and with HDL values resulting from clinical analyses (rho = 0.55, p = 0.03). At the same time, IME was inversely correlated with sedentary time measured by accelerometers (r=-0.34, p = 0.02), Insulin (rho=-0.57, p = 0.02), and Triglycerides (rho =-0.61, p = 0.01). Sedentary time measured by accelerometers directly correlated with triglycerides (rho = 0.498, p = 0.002) and inversely correlated with HDL (inverse correlation: rho = -043, p = 0.01) values. Total activity measured by accelerometer also correlated directly with HDL (rho = 0.488, p = 0.003) and inversely with insulin and triglycerides (rho = -0.332, p = 0.048; rho = -0.371, p = 0.03). The complete correlation table is provided in Supplementary Table 1.

Tables 2 to 5 compare hybrid and on-site workers' physical, psychosocial, psychophysical, and health status. No differences were found in physical fitness. Nevertheless, concerning weekly physical activity, the IPAQ results detected that hybrid workers, when doing physical activity, performed more than double the vigorous activity of workers on-site (Table 2). Some additional benefits from the hybrid working modality appeared in the PGWBI values that reported higher general health, vitality, and total score than on-site work (Table 3). Conversely, no differences have been detected in psychophysical and health status outcomes (tables 4 and 5).

Table 2. Physical status outcomes comparison between hybrid and on-site workers.

		Hybrid workers	**On-site workers**
CFT	Ruffier index (AU)	8.1 ± 2.8	8.8 ± 2.9
	30-second push-up (AU)	4.1 ± 1.8	4.0 ± 1.9
	30-second seated sit-up (AU)	5.9 ± 3.6	7.2 ± 3.7
	Shoulder mobility (cm)	56.1 ± 9.7	51.3 ± 9.1
	Chair Sit & Reach (cm)	-9.6 ± 12.8	-5.3 ± 14.9
	Index of motor efficiency (AU)	49.9 ± 11.3	49.5 ± 11.8
IPAQ	Vigorous activity (MET)	1216.4 ± 1360.3 *	553.3 ± 891.6
	Moderate activity (MET)	612.0 ± 828.6	774.0 ± 1044.3
	Walking activity (MET)	957.0 ± 1425.9	995.3 ± 1297.6
	Sitting activity (min/day)	562.4 ± 137.6	528.3 ± 119.5
	Total activity (MET).	2785.4 ± 2331.6	2326.0 ± 1783.5
Accelerometer	Vigorous activity (min/week)	31.4 ± 49.4	19.7 ± 46.8
	Moderate activity (min/week)	940.8 ± 346.8	964.9 ± 428.3
	Light activity (min/week)	562.0 ± 125.2	520.2 ± 123.6
	Sedentary time (min/week)	8080.8 ± 461.7	8111.8 ± 559.2
	Total activity (min/week)	1534.2 ± 446.4	1504.8 ± 544.9

Values are reported as Mean±SD. MET values indicate MET-min per week. * = different than on-site workers (p<0.05).

Table 3. Psychosocial status outcomes comparison between hybrid and on-site workers.

		Hybrid workers	**On-site workers**
GSES	Self-efficacy	40.0 ± 5.4	38.3 ± 5.4
PGWBI	Total score	80.2 ± 13.0 *	72.7 ± 12.7
	Anxiety	16.4 ± 5.3	15.4 ± 4.3

	Depression	13.0 ± 2.2	11.7 ± 3.4
	Positivity and wellness	12.6 ± 2.8	11.7 ± 2.4
	Self-control	12.0 ± 1.9	11.2 ± 2.6
	General Health	12.1 ± 2.3 *	10.4 ± 2.7
	Vitality	14.0 ± 2.5 *	12.5 ± 2.8
JCQ	Decision latitude	77.9 ± 7.7 *	71.0 ± 12.8
	Job demand	32.2 ± 3.6	31.9 ± 6.6
	Social support	24.9 ± 3.8*	22.8 ± 5.2

Values are expressed in arbitrary units (AU) and reported as Mean±SD. * = different than on-site workers (p<0.05).

Table 4. Psychophysical status outcomes comparison between hybrid and on-site workers.

		Hybrid workers	**On-site workers**
NASA-TLX	Mental demand	53.5 ± 29.1	60.2 ± 22.8
	Physical demand	7.5 ± 10.1	10.0 ± 11.7
	Temporal demand	43.7 ± 22.3	40.9 ± 22.3
	Performance	33.1 ± 19.2	29.5 ± 18.1
	Effort	26.2 ± 17.4	29.5 ± 19.7
	Frustration	11.3 ± 19.7	10.9 ± 19.6
	Weighted Sum	11.7 ± 4.1	12.1 ± 2.4
TQR	Total quality recovery	14.8 ± 2.7	13.9 ± 2.7

All values are expressed in arbitrary units (AU) and reported as Mean±SD.

Table 5. Health status outcomes comparison between hybrid and on-site workers.

		Hybrid workers	**On-site workers**
Clinical parameters	Creatinine (mg/dL)	0.9 ± 0.1	0.9 ± 0.2
	Glucose (mg/dL)	84.7 ± 8.5	82.2 ± 9.5
	Insulin (µU/mL)	8.1 ± 15.1	6.6 ± 7.4
	Total cholesterol (mg/dL)	206.6 ± 44.6	206.9 ± 48.2
	Triglycerides (mg/dL)	83.6 ± 41.0	91.8 ± 61.1
	HDL (mg/dL)	63.6 ± 14.3	70.0 ± 20.4
	Cortisol (mcg/dL)	10.7 ± 2.6	12.6 ± 6.6
EHQ	Convictions	12.5 ± 3.0	13.3 ± 3.0
	Problems	18.1 ± 4.8	17.9 ± 6.0
	Emotions	9.8 ± 2.1	10.4 ± 2.3
	EHQ score	40.3 ± 9.0	41.6 ± 9.1
PSQI	Subjective sleep quality	1.1 ± 0.3	0.8 ± 0.5
	Sleep latency	1.0 ± 0.7	0.6 ± 0.7
	Sleep duration	0.3 ± 0.5	0.3 ± 0.5
	Sleep efficiency	0.2 ± 0.4	0.2 ± 0.4
	Sleep disturbance	1.1 ± 0.3	1.4 ± 0.5
	Use of sleep medication	0.0 ± 0.0	0.0 ± 0.0
	Daytime dysfunction	0.6 ± 0.5	0.5 ± 0.8
	Global PSQI score	4.0 ± 1.0	3.6 ± 1.8

EHQ and Pittsburg values are expressed in arbitrary units (AU). All values are reported as Mean±SD.

When considering relationships associating the time spent by hybrid workers in remote work and physical, psychosocial, psychophysical, and health features, direct correlations were found between the percentage of remote work and vigorous activity as measured by the IPAQ (Fig. 1). Inverse correlations resulted concerning self-efficacy (Fig. 2a) and job demand (Fig. 2b) and direct correlations were found in clinical parameters as glucose and insulin (Fig. 3a and 3b) The complete correlation table is reported in Supplementary Table 2.

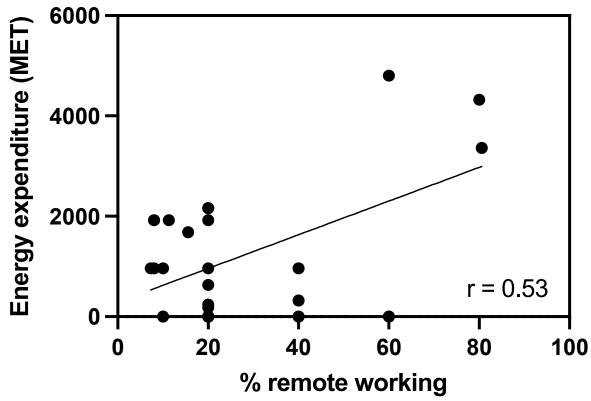

Figure 1. Correlation between remote working (as a percentage of the total weekly working hours) and exercising at a high intensity when doing physical activity (as derived from the IPAQ); p = 0.007.

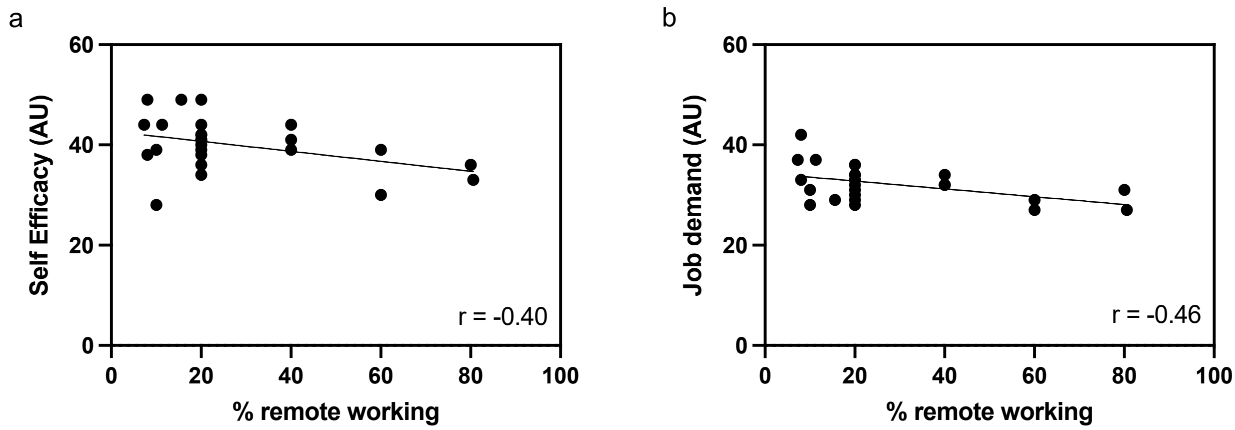

Figure 2. Correlation between remote working (as a percentage of the total weekly working hours) and psychosocial outcomes. In panel a: Self-efficacy (p = 0.049); in panel b: JCQ Job demand (p = 0.019).

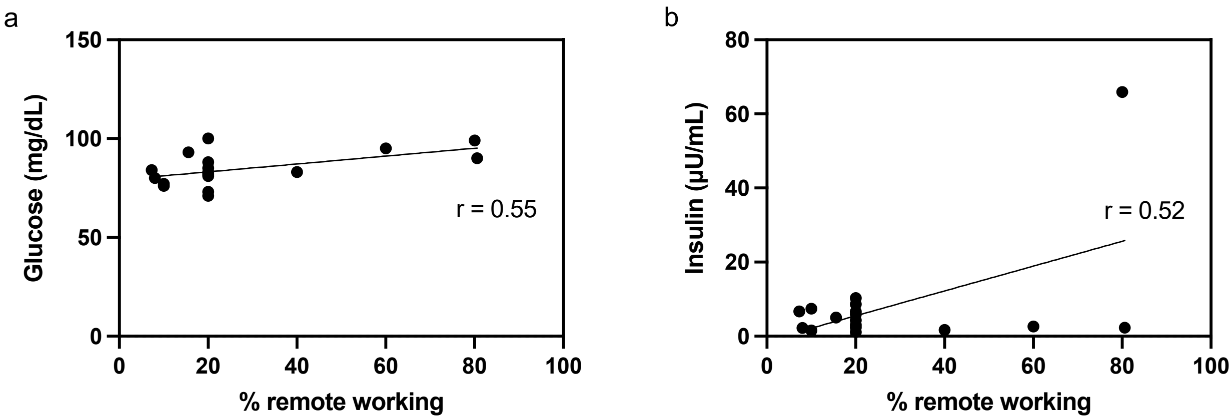

Figure 3. Correlation between remote working (as a percentage of the total weekly working hours) and clinical parameters. In panel a: Glucose (p = 0.023); in panel b: Insulin (p = 0.003).

4. Discussion

This work aimed to investigate whether hybrid work may represent a valid working modality to integrate the advantages of remote and on-site work, limiting the adverse effects. Physical efficiency, weekly physical activity, and health are correlated in several aspects. Hybrid workers seem to perform a more vigorous activity than workers on-site and have better psychological status. The time spent in remote working by hybrid workers directly correlates with vigorous physical activity and some clinical parameters but negatively correlates with self-efficacy and job demand.

4.1. Physical efficiency, weekly physical activity, and health (clinical parameters) in desk workers

Work constitutes a substantial portion of the present study participants' daily life (over 6 hours), making it essential to examine its impact on areas of well-being (physical, psychosocial, psychophysical, and health). Indeed, the literature indicates that desk workers are prone to increased sedentary time and that the work environment plays a crucial role in physical efficiency and health (Landais et al. 2022).

To comprehensively understand our participants' health and physical well-being, exploring the connections between physical efficiency, motor activity, and clinical parameters is essential. In this study, the results from the CFT (which explores physical efficiency) significantly correlated with various outcomes related to weekly physical activity, including accelerometer and IPAQ measures, and with some clinical parameters. The CFT well discerned movement-induced physical efficiency. It is worth noting that the CFT has proven effective in increasing awareness of movement and adjusting exercise intensity based on individual's physical and mental state. This is allowed by practicing using perceived effort as a reference point for testing (Invernizzi et al. 2021, 2022; Signorini et al. 2023), which extend to exercising management. Therefore, CFT could also go beyond its application as an assessment tool: it might be effectively employed to motivate hybrid workers to persist in physical activity further, positively influencing physical literacy throughout their lives (Boldovskaia et al. 2023).

Correlation analysis between CFT and clinical parameters supports the relationship between movement and physical efficiency. Physical efficiency was inversely correlated with insulin and triglyceride levels and directly with HDL cholesterol values, which indicates a connection between physical efficiency and health. Movement quantity was directly correlated with HDL cholesterol levels (indicating better metabolic health) and inversely with triglyceride levels. Additionally, more sedentary time correlated inversely with HDL levels and directly with blood glucose levels, highlighting that increased sedentary behavior worsens health-related blood parameters. The results agree with the literature claiming that physical efficiency, physical activity quantity, and health levels are closely intertwined in a desk workers' population (Ford et al. 2010; Pinto et al. 2023). The subsequent analysis will explore how working mode can influence the above and other health-related factors by examining physical, psychosocial, psychophysical, health-related, and clinical states.

4.2. Difference between on-site and hybrid work (absolute comparison)

The office work system is diverse and complex, with various job types and tasks that are challenging to categorize. Work environments can be classified based on their intended mode, whether on-site, hybrid, or remote (Uru, Gozukara, and Tezcan 2022). This characteristic opens up different possibilities and modes of interaction for workers with the work environment that can significantly alter not only the psychophysical approach to work but also the organization of the workers' private lives, both in terms of relationships and healthy lifestyle routines (Garwood and Poole 2021). In our study, employees undertaking hybrid work showed better outcomes in some well-being and health-related aspects than on-site workers, in line with what has already been highlighted in the literature (Uru et al. 2022).

4.2.1. Physical status

Regarding the amount of physical activity, the workers opting for hybrid work spent a significantly higher number of minutes in activities defined as intense (meaning activities that require high physical effort causing a considerably higher than regular breathing rate, which makes it difficult to speak Hallal and Victora 2004) than colleagues opting for on-site working. The literature demonstrated that, compared to on-site workers, workers from home generally spend less time in activity and are more sedentary (Wells et al. 2023). A qualitative and quantitative study by Burton & Turrell reported that workers are less active while working remotely because no interaction with colleagues requires them to get up from the workstation. When working remotely, communication with colleagues is typically done via phone or computer calls, forcing the worker to remain at the workstation for extended periods (Burton and Miller 1998).

Our results show that hybrid workers are comparable to on-site workers regarding physical activity, somewhat better when considering intense activity that is much more, as the IPAQ analysis reported (Table 2). Even if we do not directly compare them to fully remote workers (we only compared on-site and hybrid workers), we found that hybrid workers spent more intense physical weekly activity than on-site workers, which can be reasonably extended to also assuming superiority over remote workers', being the latter generally poorly active (Wells et al. 2023). In recent years, the hybrid working modality has become increasingly consolidated, bringing workers some advantages of remote work, such as managing time to integrate physical activity into their daily routines (Tagliaro and Migliore 2021). The participants of this study, who are partially working remotely, might have well-managed personal time, which facilitated them to engage in vigorous physical activities outside of working hours. In addition, physical activities are often chosen to be performed near one's residence more than anywhere (Giles-Corti and Donovan 2002). We can speculate that reducing commuting time from the workplace to the home could have represented a further facilitating component favoring participation in sports and physical exercise with a vigorous effort request. Indeed, among the participants of the present study, hybrid workers performed extra hours of intense activity per week (two hours) compared to on-site workers (one hour) and fully reached the target of

75 to 150 minutes of weekly vigorous activity prescribed by the WHO guidelines (World Health Organization 2020). The hybrid modality and other psychosocial characteristics that differentiate hybrid from on-site workers, such as improved self-efficacy, possibly compensates for the sedentary time with the increasing out-of-work vigorous physical activity. This will be discussed in the following paragraphs.

4.2.2. Psychosocial status

Concerning general psychosocial health, hybrid workers showed higher levels of psychological well-being (nevertheless, based on mean scores, the participants of both groups were allocated in the "non-distress" area), general psychological health, and notably greater vitality. Deepening the PGWBI sub-scales, it is clear that the on-site working group had values below the average score, while those with hybrid work fit perfectly within the standard average expected by the PGWBI questionnaire, in line with the literature (Crawford 2022; Uru et al. 2022). As suggested by the JCQ results, this could be attributed to greater decisional autonomy of the hybrid working group. Several studies have highlighted that a high sense of autonomy (both at work and in daily life) is a fundamental support for individual well-being, both physically and psychologically (Lange and Kayser 2022). Hence, the hybrid work allowed to maintain the on-site work advantages (like social relationships and the avoidance of loneliness Becker et al. 2022; Ferreira et al. 2021) with the addition of the work-life balance positive effects due to working from home.

4.2.3. Psychophysical status

The NASA TLX confirmed that despite performing tasks in different modes, no differences can be retrieved between hybrid and on-site workers in the psychophysical area. They had no different workloads and were homogeneous regarding workload type and intensity. Additionally, no differences were found in the TQR, indicating that during the data collection session, the psychophysical recovery of all participants was consistent and did not influence the results (Signorini et al. 2023).

4.2.4. Clinical status

The lack of difference between hybrid and on-site workers when comparing clinical analysis results is not surprising, as no differences have been found in the total index of motor efficiency of the CFT and the total amount of physical activity. As previously highlighted, physical efficiency, physical activity, and clinical parameters are strictly related. Hybrid and on-site workers did not differ enough in overall physical behaviors to evidence effects in their clinical parameters. Nevertheless, the higher vigorous physical activity of hybrid workers could have contributed to lowering the gap between on-site and remote workers, as reported by the literature (Kizilay et al. 2016).

4.2.5. Other Health-Related Factors

The work mode does not affect dietary habits or sleep, two additional health-related variables. A review by Clohessy et al. (Clohessy, Walasek, and Meyer 2019) reported how office work negatively influences dietary habits due to three main aspects: job-related, social, and other factors related to the work environment. The role within the company and the work pressure from assignments are high-risk factors for dietary habits, transcending the work mode for all workers. Environmental factors (the availability of healthy food, proximity, and ease of access to food sources) significantly vary when considering office or remote work. The same applies to social factors (e.g., the influence of colleagues and everyday work routines). However, these differences did not affect the EHQ results. This could be due to the low amount of remote work (an average of 1.5 ± 1 days), probably insufficient to significantly change dietary habits without proper dietary education (Glympi, Chasioti, and Bälter 2020). The same reasoning applies to sleep. Despite the various studies showing the adverse effects of remote work on sleep, no differences were found. Most studies have considered workers with a very high number of remote work days and were conducted during the COVID-19 pandemic (Conroy et al. 2021; Costa et al. 2022), while the hybrid workers of this study had an average of eleven remote hours per week.

4.3. Hybrid working: How much? (relative comparison)

Starting from the assumption that hybrid working generally delivered better physical activity propension and well-being results, this section will analyze how these factors vary as the amount of remote work performed varies.

Regarding physical activity, more hours spent in remote work facilitates vigorous physical activity, which supports the findings of the absolute comparison (hybrid vs. on-site work). Thus, promoting hybrid work might enhance exercising during leisure time.

In the psychosocial domain, more weekly hours spent in remote work inversely correlated with job demand (composed of psychological and physical demand), which aligns with literature indicating that increased remote work is associated with lower psychological and physical demands (Burton and Turrell 2000; Wontorczyk and Rożnowski 2022). The lower job physical demand can suggest that, in the relative analysis, hybrid workers working more hours remotely spent less time in physically active behavior during working hours but possibly compensated with vigorous physical activity outside working hours, as previously already hypothesized. The inverse correlation between the percentage of remote working and the hybrid worker's self-efficacy (Fig. 2) indicates that self-efficacy decreases as remote working hours increase. In a hybrid working modality, fewer days spent in remote work allow one to maintain working autonomy (typical of remote work) and to increase work-related self-efficacy due to a more direct relationship with colleagues and superiors. This can enhance the sense of work-related self-efficacy (compared to higher remote working hours), as reported in the literature (Chan et al. 2017).

Clinical parameters showed a link between the increase in hybrid workers' remote working hours and blood glucose and insulin levels (Fig. 3). Higher glucose and circulating insulin levels are associated with more distress (Goetsch, Abel, and Pope 1994). As mentioned earlier, more remote working hours reduce the sense of self-efficacy at work, possibly enhancing stress-related outcomes (Singh et al. 2019). Therefore, hybrid workers who spend less time in remote work could be less stressed due to higher involvement in their work organization (Becker et al. 2022). Moreover, this higher involvement could bring more opportunities for relationships with superiors and colleagues, enhancing their sense of belonging and being an active and influential part of the company (Santhanam, Balaji, and Joseph 2022).

The results can finally be summarized and conceptualized (Fig. 4): more hours spent remotely by hybrid workers facilitate engaging in more active lifestyles outside working hours. Nevertheless, workers with less remote work have superior self-efficacy due to a higher possibility of directly relating with colleagues and supervisors, maintaining working autonomy. The clinical parameters confirmed this statement (more hours spent in remote work worsens some clinical stress-related parameters).

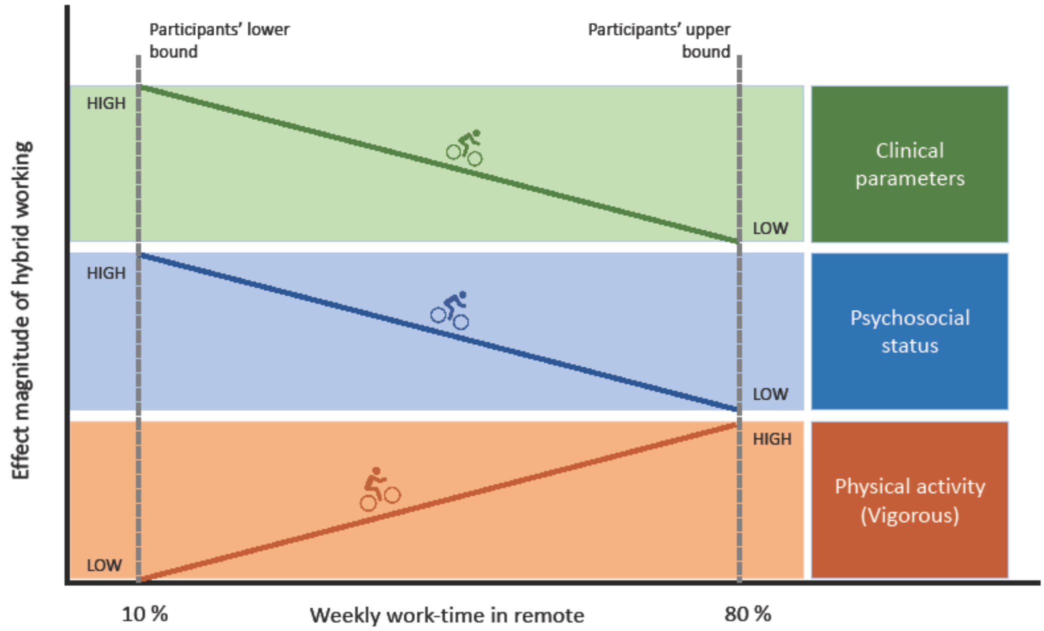

Figure 4. Conceptual representation of the magnitude of primary effects of hybrid work on clinical parameters (green), psychosocial status (blue), and vigorous physical activity (orange). The 10% and 80% percentages correspond to the lower and upper bound of the participants' remote working time over the weekly working hours.

4.4. Limitations

As a main limitation, we must acknowledge that a broader and more differentiated sample representing a wider spread of weekly working hours would have supplied more representative data of different proportions of hybrid work, better fitting the population of desk workers. In addition, a more in-depth investigation of the type of physical exercise carried out by employees during the week would have brought helpful information to interpret better the results relating to vigorous physical activity. Finally, the small number of participants also limited the possibility of categorizing optimal on-site and working-from-home percentages and estimating the more successful composition of hybrid working.

4.5. Practical applications

Hybrid work resulted in an optimal compromise between on-site and remote work. Nevertheless, even if hybrid working allows more vigorous physical activity outside of work, desk workers must avoid isolation and social integration that can cause psychological discomfort and consequent adverse effects on clinical parameters (Becker et al. 2022). Proactive environments in which physical activity is blended into the usual workflow, such as the UP150 project (Invernizzi et al. 2022), are valuable to increasing the amount of general activity status, even in hybrid working. The present research outcomes can be applied to improve welfare projects and to maintain a more direct link with the new working habits trends.

5. Conclusions

A desk-work environment reduces the time spent in active lifestyles, which is strictly related to physical efficiency and clinical health parameters. Hybrid working could encourage vigorous physical activity outside working hours and improve psychological status. Nevertheless, results indicate that even if hybrid work brings more benefits to health and well-being than on-site work, it is necessary to investigate the adequate proportions of remote to the weekly working hours and to define the most suitable working setting.

Annex

Annex 1. Correlation Table for weekly physical activity, physical efficiency, and health variables

Variable	Sedentary activity (IPAQ)	Total activity (IPAQ)	Sedentary (Accelero-meter)	Total activity (Accelero-meter)	Creatinine	Glucose	Insulin	Total cholesterol	Triglyceride	HDL	Cortisol
IME (CFT)	-0.114	*0.239*	**-0.335***	**0.283***	0.162	-0.221	***-0.468*****	0.230	***-0.504*****	***0.526*****	*-0.209*
Sedentary activity (IPAQ)		*-0.056*	0.179	-0.177	0.029	**0.445****	*0.254*	0.033	*0.095*	*-0.166*	*0.027*
Total activity (IPAQ)			*-0.111*	*0.196*	*0.179*	*0.141*	*-0.045*	*0.107*	*0.042*	*0.227*	*-0.268*
Sedentary (Accelerometer)				**-0.955*****	0.102	0.001	*0.267*	-0.154	***0.498*****	***-0.430*****	*-0.089*
Total activity (Accelerometer)					-0.111	0.008	***-0.332****	0.224	***-0.371****	***0.488*****	*0.000*
Creatinine						-0.004	*0.279*	-0.001	*0.094*	*-0.239*	*-0.066*
Glucose							***0.383****	0.064	*0.019*	*-0.017*	*0.076*
Insulin								*-0.202*	***0.476*****	***-0.547******	*0.115*
Total cholesterol									*0.177*	***0.545******	*-0.228*
Triglycerides										*-0.253*	*0.054*
HDL											*-0.096*

The table reports the Pearson-r correlation values or the Spearman's rho values (in italics). Significant correlations are highlighted in bold (* = $p<0.05$; ** = $p<0.01$; *** = $p<0.001$). IME: Index of Motor Efficiency; CFT: Cubo Fitness Test; IPAQ: International Physical Activity Questionnaire.

Annex 2. Correlation Table for time spent by hybrid workers in remote work (percentage of remote working per week) and physical, psychosocial, psychophysical, and health status

Area	Measure	Variable	Correlation with % Hybrid work
Physical status	CFT	Ruffier index	0.323
		30-second push-up	-0.086
		30-second seated sit-up	-0.002
		Shoulder mobility	0.129
		Chair Sit & Reach	-0.063
		Index of motor efficiency	-0.356
	IPAQ	Vigorous activity	**0.527****
		Moderate activity	*0.268*
		Walking activity	*0.055*
		Sitting activity	-0.260
		Total activity	0.303
	Accelerometer	Vigorous activity	*-0.022*
		Moderate activity	0.119
		Light activity	-0.171
		Sedentary time	0.059
		Total activity	0.078
Psychosocial status	GSES	Self-efficacy	**-0.398***
	PGWBI	Total score	-0.091
		Anxiety	0.133
		Depression	*-0.140*
		Positivity and wellness	-0.092
		Self-control	*-0.184*
		General health	-0.046
		Vitality	-0.239
	JCQ	Decision latitude	-0.175
		Job demand	**-0.466***
		Social support	-0.054
Psychophysical status	NASA-TLX	Mental demand	0.062
		Physical demand	*0.174*
		Temporal demand	-0.063
		Performance	-0.115
		Effort	-0.135
		Frustration	*0.135*
	TQR	Total quality recovery	0.012
Health status	Clinical parameters	Creatinine	0.240
		Glucose	**0.548***
		Insulin	**0.520****
		Total cholesterol	-0.117
		Triglycerides	*0.027*
		HDL	*0.023*
		Cortisol	*0.095*
	EHQ	Convictions	-0.102
		Problems	-0.018
		Emotions	-0.071
		EHQ score	-0.060
	PSQI	Subjective sleep quality	0.023
		Sleep latency	0.437
		Sleep duration	*-0.562*
		Sleep efficiency	*-0.531*
		Sleep disturbance	-0.406
		Use of sleep medication	.a
		Daytime dysfunction	-0.296
		Global PSQI score	-0.035

The table reports the Pearson-r correlation values or the Spearman's rho values (in italics). Significant correlations are highlighted in bold (* = p<0.05; ** = p<0.01). CFT: Cubo Fitness Test; IPAQ: International Physical Activity Questionnaire; GSES: General Self-Efficacy Scale; PGWBI: Psychological General Well-being Index; JCQ: Job Content

Questionnaire; TQR: Total Quality Recovery Scale; EHQ: Eating Habits Questionnaire; PSQI: Pittsburgh Sleep Quality Index.

Design and construction A (*Step 4*)

From Analysis and Exploration A and B (*Steps 1 and 2*), the CFT resulted adequate to be inserted in a specific environment such as the workplace. Moreover, analysis and exploration study C (*Step 3*) highlighted the effect on the psychophysical health of the hybrid work modality. Hence, with the support of this preliminary knowledge, *Step 4* involved the introduction of the entire UP150 concept in a controlled working environment where employees inserted in the concept could work entirely immersed in the working environment specifically created for them. Data on the concept design's efficacy will be analyzed with a randomized controlled trial.

The UP150: a multifactorial environmental intervention to promote employee physical and mental well-being.

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Abstract

Physical activity (PA) is a major health factor and studies suggest workplaces could promote PA by modifying office design, motivational strategies and technology. The present study aims to evaluate the efficiency of UP150, a multifactorial workplace intervention for the improvement and maintenance of the level of physical fitness (PF) and wellbeing. Forty-five employees were randomly divided into the experimental (EG) and control (CG) groups. The PF was assessed pre-post intervention using the cubo fitness test (CFT), the amount of PA was evaluated using the IPAQ questionnaire and accelerometers while the workload was assessed using the NASA-TLX questionnaire and psycho-physical health by using the SF-12 questionnaire. The EG worked in UP150 offices while the CG worked in their usual offices for 8 weeks. The EG and CG came back 4 weeks after the intervention for CFT retention. The EG improved CFT motor efficiency and the amount of moderate PA, while it reduced mental load. The EG retained reached motor efficiency levels 4 weeks after the intervention. No differences were found in IPAQ. The UP150 demonstrated to be a proactive environment and to be efficient in the promotion of PA, improving PF and mental health while decreasing mental load.

Keywords: motor efficiency; workplace; physical activity; self-determination; effort perception

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1. Introduction

The workplace represents one of the main causes of sedentarism and stress, which negatively affect the quality of life (World Health Organization 2010). The incoming of the SARS-CoV-2 pandemic has changed usual working habits and has introduced the concept of smart working, which has caused a reduction in the costs for the companies accompanied by a reduction in employees' working involvement and a decrease in working performances (Bolisani et al. 2020; Chanana and Sangeeta 2020). To act on the movement's education and on employees' motivation, a methodology is proposed that can determine an easy and non-traumatic transition from the classic workplace concept (based on constriction, stress and health risks due to a sedentary lifestyle) to a new workplace environment and office's design concept, which consider the well-being and the caring of employees as central elements of companies' welfare strategies (Sica 2021). The innovation of this methodology consists of the insertion of systems that can increase the motivation to perform physical activity, through the increase in autonomy, relatedness, and the positive perception of self-motor competence (Ryan 2012). More specifically, a training system is proposed based on effort perception, which aims to integrate physical activity to professional working rhythms, promoting a conscious physical practice, adequate to the individual's psycho-physical condition and to the working context.

The present research is an explorative study that aims to investigate the efficiency of a multi-component workplace intervention (UP150). In particular, the research aims to evaluate if the UP150 has efficacy in improving and maintaining the level of physical fitness, increasing the amount of weekly physical activity (reaching the WHO recommendations), decreasing the amount of perceived mental stress and decreasing the perceived mental load, using a training system based on self-perception and on the methodological principles of self-determination theory. Literature Review The benefits of physical activity (PA) are widely known in the literature. Recent research reported that active people's mortality risk is reduced by about 33% for all death causes, and about 35% for cardiovascular causes (Nocon et al. 2008). Furthermore, PA has an important role in the primary (healthy individuals), secondary (sick individuals) and tertiary (control of a diagnosed disease) prevention in most of noncommunicable diseases (NCDs). Active lifestyles contribute in the prevention of coronary and atherosclerotic disease that are recognized as 31% of all death causes (Alves et al. 2016; Darden, Richardson, and Jackson 2013). This health-generating effect has efficacy even in the prevention of metabolic syndromes, which has, as a consequence, the onset of diabetes and heart disease (Saklayen 2018). PA is known to be bound to the reduction in the risk of different cancer types and chronic obstructive pulmonary disease (Oliveira et al. 2020; Tong et al. 2019; Warburton and Bredin 2017). One of the main areas affected by PA is physical fitness, which is defined by Kilgore et al. (Kilgore and Rippetoe 2007) as the "possession of adequate levels of strength, endurance, and mobility to provide for successful participation in occupational effort, recreational pursuit, familial obligation, and that is consistent with a functional phenotypic expression of the human genotype". Based on the proposed definition, cardiorespiratory, muscular and flexibility are identified as the main components of physical fitness. More specifically, recent research assesses that cardiorespiratory training can reduce mortality by 11.6% for all death causes, 16% for cardiovascular disease and of 14% for cancer (Imboden et al. 2018). Muscular training is found to have positive effects on body composition, on insulin resistance, on self-esteem and on cardiovascular health (Westcott 2012). Moreover, muscular training can improve and maintain the functions of musculoskeletal and neuromuscular systems, permitting an adequate autonomy through lifespan (Marcos-Pardo et al. 2019; Pereira et al. 2010). Flexibility training has positive effects on mechanical systems, increasing the articular ROM and muscles' stretching capacity, preserving the independence of simple daily actions (such as washing, dressing and using the stairs) and reducing musculoskeletal issues that can produce articular pains (such as cervical pain or shoulder pain) and functional limitations that can be cause of falls (more frequents in the elderly) (Chiacchiero et al. 2010). Furthermore, the research of Mueck-Weymann (Mueck-Weymann, Janshoff, and Mueck 2004) reported that the heart rate variability of healthy adults can be positively affected by a stretching program of 7 weeks, probably through an activation of the parasympathetic nervous system. Another research concerning flexibility, conducted in the workplace, evidenced that an intervention of 10 min per day, for 5 days a week for 3 months, can reduce employees' anxiety, pain, fatigue and, at the same time, increase mental health and vitality (Montero-Marín et al. 2013). Moreover, the effects of physical activity on mental health have been well documented in recent years. It has been supposed that the antioxidant effect of physical exercise can positively impact mood disturbances related to oxidant stress (Hearing et al. 2016). Furthermore, PA effects promote the increase in some cerebral functions, such as learning and memory; in addition, it can also reduce cerebral disease (such as Alzheimer or Parkinson) and age-related cognitive declines (Baek 2016; Booth and Ruegsegger 2018). The effects of PA on mental health must be considered not only as a preventive tool, but even as an everyday instrument to improve the quality of life, thanks to physical exercise's ability of giving a better body's image, of reducing anxiety, stress and of promoting independence (Anderson and Shivakumar 2013; Bassett-Gunter et al. 2017).

Based on previous affirmations, and on the existing literature, it can be asserted that physical inactivity can already represent by itself a risk factor for public health (Blair 2009; Zelle et al. 2017). Considering the costs of this risk factor, the World Health Organization reported that the sanitary costs of each country attributable to physical in activity range from 1% to 3% (World Health Organization 2018). Recent data assess that the 27.5% of world population is not active enough, a percentage that increases to 36.8% when considering only higher-income countries (Guthold et al. 2008). The evidenced problems seem to have been worsened due to SARS-CoV-2 pandemic. An increasing amount of time spent in sedentary behaviors and a decrease in time spent in active or moderate activities has been highlighted (Ammar et al. 2020). Even the number of steps performed during a typical week day has been affected by the restrictions imposed by country's policies, evidencing a decrease of 27.3 % thirty days after WHO declared COVID-19 a pandemic disease (Tison et al. 2020). One suggested solution is to promote physical activity and healthy lifestyles on the workplace, due to the elevated percentages of occupational diseases (70%) represented by NCDs caused by unhealthy behaviors (World Health Organization 2010). It is important to consider that employees spend about half of their day in the workplace (Holtermann et al. 2021), and most common jobs require sedentary activities for a prolonged time, increasing the time spent in sedentary behaviors (2 h/day during a week day). From this point of view, it could be difficult for the employees to reach the recommended 150–300 min of moderate physical activities or the 75–150 min of intense physical activities (Bull et al. 2020). The Global Action Plan on physical activity 2018–2030 (World Health Organization 2018), identifies the workplace as key to promoting physical activity by introducing active pauses, salutary physical activity and active urban mobility. Possible advantages caused by this type of intervention are the increase in employees' wellness, productivity and soft skills (developing social relations and problem-solving capacities); the reduction in absenteeism; and cost reductions in public health (Grimani et al. 2019; McEachan et al. 2011). In the same global action plan, it is highlighted that the workplace intervention must be focused on creating active environments, modifying the architectural structures of the workplace, and on creating active people, intervening on the employees' lifestyle (World Health Organization 2018). Based on the cited literature, the main research question is: how to create active environments and active people? In research conducted by Pronk in 2021 (Pronk 2021), four sociological intervention levels were identified: Individual level: based on individual consultancies, a dynamic work station (standing and sitting desks) and on the use of treadmill or stairs in active pauses or obliged routes in the office. Group level: introducing, in the working daily routine, group active pauses of 10 min, promoting online physical activities, walking groups and social support network. Environmental communication level: using printed billboards or personalized online messages (in order to promote healthy behaviors and physical activity), pedometers and informative campaigns. Policy and physical environment levels: promoting the creation of safe bicycle parking, the insert of changing rooms in the workplace and health programs. In addition, the literature underlines that another important aspect to consider in the promotion of physical activity and creation of an active environment is motivation (Ntoumanis et al. 2018). The lack of adequate motivation in conducting an active lifestyle could cause the early abandonment of the structured promotion program (Bardus, Blake, Lloyd, and Suzanne Suggs 2014). In order to prevent this issue, it is important to refer to a behavioral and motivational theoretical framework. In recent years, the self-determination theory (SDT) has been considered by many authors. This theory affirms that people are moved by three inner psychological needs: autonomy, competence and relatedness (Deci and Ryan 2012). SDT has been widely suggested in the working context to develop the autonomy and proactivity of the employees in reaching working goals (Marylène Gagne 2014). In addition, as evidenced by Deci and colleagues (Deci, Olafsen, and Ryan 2017), autonomy, competence and relatedness can be considered as a mediator of health and wellness in the workplace and of physical activity (Teixeira et al. 2012). The autonomy is the need to self-organize one's own experience and one's own behavior. Being autonomous means deciding and self-approving all actions in order to reach a specific goal (Deci and Ryan 2012). In this psychological need, the goal setting theory (Tosi, Locke, and Latham 1991) seems to be effective to promote motivation and autonomy. In this theory, it is asserted that, when a task is perceived as too easy or too difficult, motivation decreases, while if the task is perceived as moderately difficult, motivation raises. This is supported by Brehm and colleagues who, moreover, assert that an increasing level of potential motivation due to a positive perception of the goal can increase the amount of effort dedicated in the achievement of the goal (Brehm 1989; Wright 2008). From this point of view, programs that aim to include physical activity promotion need to include adequate exercise in order to stimulate interest during practice. The competence is represented by the need of feeling efficient in one's own social and physical world, the task required has to be adequate to the subject's characteristics and the goals have to be clear. Relatedness is the need to feel connected with others, creating bonds and experimenting with belonging and intimacy; the individuals need to feel understood and positively evaluated. Another important factor that may influence the employees' motivation can be perceived in the offices' design. It has been demonstrated that this latter factor has an important role in motivation enhancement (Maria and George 2015). In particular, the office's design can reduce sitting time in employees acting on the environmental/spatial factor as workstations, furniture, office size, office density, shared spaces, corridors and stairs (Sugiyama et al. 2019). As previously explained, the increase in motivation is helped by the development of competence, which is composed by the acquisition of abilities and knowledge (Le Deist and Winterton 2005). In order to sensibilize, educate and increase the knowledge of the employees about healthy lifestyles, recent researches have considered the inclusion of a new professional figure in the workplace environment, the wellness coach (Baicker et al. 2010; Butterworth et al. 2006). Wellness coaches have been shown to have great efficacy health risk prevention and in the promotion of active lifestyles even in workplace (Blackwell et al. 2019). Moreover, the education to move and be active, given by the wellness coaches, is essential to create new abilities due to new routines and automatism, which could facilitate the approach to physical activity during working hours (Carlsson and Walden 2019). The inclusion of this new type of professional inside the working environment could contribute in enhancing the motivation to pursue physical activity and active lifestyles (Blackwell et al. 2019). According to Commissaris and colleagues, a systematic review underlines that multicomponent approaches (individual, organizational and environmental changes) can have more efficacy than single component approaches (Commissaris et al. 2016). A study conducted by Maylor and colleagues (Maylor et al. 2018) comprised a multi-component intervention named "Beat the Seat", which aimed to reduce the amount of time spent in the sitting position during the workday, intervening on organizational, individual and environmental elements. The results showed that the intervention contributed to reduce the time spent in the sitting position and increased the amounts of transitions from the sitting to standing position and the number of steps performed during the workday. Another multi-component intervention, proposed by Nooijen and colleagues (Nooijen et al. 2019), aimed to promote physical activity through the use of the company gym, walks during the lunch breaks and standing or walking meetings. The study underlines that, after 6 months from the start of the intervention, employees' self-efficacy and motivation to approach physical activity increased significantly. It is supposed that participants involved in the new proposed working environment could present higher levels of physical fitness and psychological well-being than a similar group in a standard working environment, considering both in-presence and smart working. Moreover, it is supposed that participants inserted in the new offices could increase the time spent in physical activities and maintain the improved physical fitness.

2. Methods

2.1. Sample

Forty-five employees volunteered to participate and were randomly divided into an experimental group (EG = 23) and control group (CG = 22). Only employees of the company that hosted the trial were included. Conversely, all the employees that presented psychological or physical disabilities were excluded from the experimental procedure. Moreover, the participants were excluded from the analysis if they did not complete all the expected evaluations or if they reached a percentage of work absenteeism greater than 10% during the experimental procedure. During the experimental period, 5 participants (2 males and 1 female in the EG and 2 males in the CG) were no longer able to follow the procedures and were excluded from the analysis. At the end of the experimental procedure, both of groups were composed of 20 participants each (12 females and 8 males for each group). The participants of the EG were 31.7 ± 8.2 years old, with an average weight of 67.6 ±17.0 kg and an average height of 1.7 ± 0.1 m (BMI= 22.6 ± 2.7 kg/m^2). Similarly, the participants of the CG were 32.0 ± 4.4 years old, with an average weight of 64.8 9.9 kg and an average height of 1.7 ± 0.1 m (BMI= 22.9 ± 3.9 kg/m^2). The study was conducted in accordance with the declaration of Helsinki and was approved by the ethics committee of the University of Milan (14 September 2020, number 84/20).

2.2. Protocol

The study was conducted following the structure of the randomized controlled trial. The first phase (pre-test) aimed to investigate the characteristics of the sample, proposing the cubo fitness test (CFT), and a set of questionnaires. The CFT was administered in 3 different sessions every 5 days to assess reliability. Moreover, in this phase, all participants wore the accelerometers for a week (detection 1). In the second phase (training), the participants were equally divided into two groups (EG and CG) with an equal amount of weekly physical activity measured in the first phase with the accelerometers and the international physical activity questionnaire. The EG worked three times a week in the new concept office and two times a week in smart working for eight weeks. During this period, the EG was subjected to the experimental procedures. The CG worked alternatively in their normal offices separately from EG (three times a week) and in smart working (two times a week) as usual. The CG was not allowed to interact with the procedures determined for the EG. In this phase, the physical activity of both groups was measured with the accelerometers, alternatively one week each, assessing three weeks for each group during the entire experimental period (detection 2, detection 3 and detection 4). In addition, all the participants had to report daily the total quality recovery value (at work entrance), the adapted Borg scale's value (when leaving work) and the training load (calculated by multiplying the adapted Borg's value by the working minutes of the day). After the expected eight weeks, in the third phase (post-test), the participants repeated the CFT and the set of questionnaires. In the fourth phase, all participants interrupted the experimental procedures for four weeks, and subsequently they repeated the CFT and the international physical activity questionnaire (retention test). The entire protocol is shown in Figure 1.

2.3. Assessment

All tests were administered in a dedicated test room inside the workplace office with a fixed temperature of 22 C° and with a standard humidity percentage of 40%. During the entire experimental period, participants followed the national indications for SARS-CoV- 2 prevention.

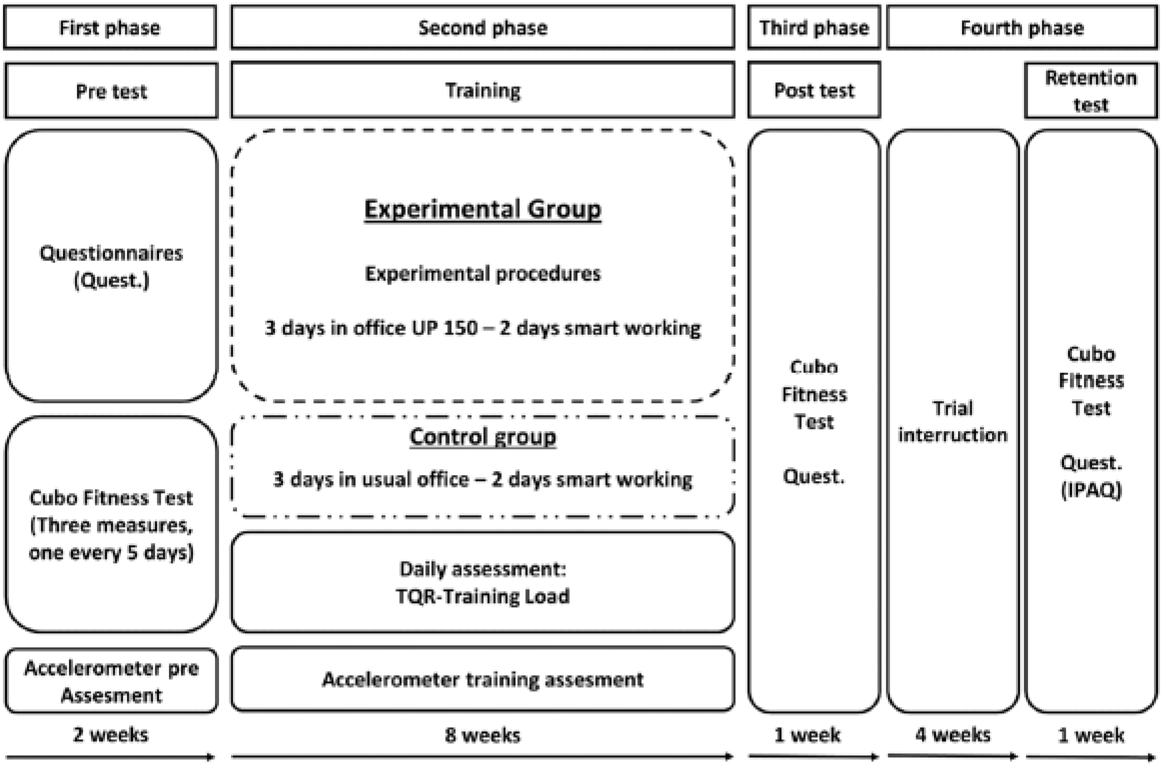


Figure 1. Protocol of the study.

2.4. Procedures

2.4.1. Architectural Changes

The employees of the EG worked in new offices projected and developed by the specialized society "Progetto Design and Build S.r.l.". The new concept of the office, named "Ufficio Proattivo 150" (UP150), was projected not only in order to include a set of physical activities stations that aimed to integrate movement during active pauses or during workflow, but even in order to create an environment that can increase the motivation of employees and social relationships. The following section explains the details of the physical stations.

Check in wall station: Wall fixed disposal, divided into three backlit segments (low, medium and high), which had to be touched while illuminated. The low segment had to be touched with both hands performing squats; the medium segment had to be touched while performing wall push-ups; and the high segment had to be touched rising on toes and reaching as high as possible. Each segment lit up for 10 s during which the employee had to perform the respective exercise. Each exercise was repeated two times, with a total duration of 60 s. Steps station: The step station was structured as an informal meeting area, composed of steps, where employees could sit on. The structure presented two steps (of 50 cm and 90 cm) useful for performing different type of exercises (step-ups, push-ups at different heights; sit-squats and stretching for lower limbs).

Meeting rooms' bike: The meeting rooms and the phone booth were equipped with a set of cycle ergometers that allowed to perform physical activity during meetings and work calls.

Break room's treadmill: The break rooms were equipped with treadmills that allowed to walk and talk with colleagues during pauses. Steppers (toilet, vending machines, standing desks): A set of steppers were placed in different office areas. The steppers allowed to log into many office workflow activities, such as washing and drying hands, buying coffee or snacks, or just stepping while working. To log into the activity, the employee had to perform at least 30 s of steps. The employee could also choose to bypass the procedure and to freely log into the activities without performing the exercise.

Steps station: The step station was structured as an informal meeting area, composed of steps, where employees could sit on. The structure presented two steps (of 50 cm and 90 cm) useful for performing different type of exercises (step-ups, push-ups at different heights; sit-squats and stretching for lower limbs).

Rubber bands (break room and standing desks): A set of rubber bands with three different difficulties were placed in the break room and at the base of standing desks. These bands were useful to perform some simple exercises bound to muscular fitness for upper and lower limbs (at least 30 s for each exercise).

Reclining fitness bench: A dedicated area was equipped with a reclining bench that allowed the execution of stretching for lower limbs, sitting sit-ups with different inclinations of the bench and push-ups.

Wooden stick: The office's common areas were equipped with wooden sticks. These sticks allowed to perform exercises for shoulder and upper limb mobility.

2.4.2. App UP150

It is an application for mobility, developed by the society Business Integration Partners S.p.A. (Milan, Italy). The application includes the pocket trainer (PT), the training diary (TD), and physical activity score tools (PAS), which are explained in detail in the following sections. The App UP150 was developed to simplify the interaction process between the employee and the physical activity inside and outside the workplace. The application had to be activated at the entrance using the QR code linked to the "check in wall" or at home selecting a general check-in exercise. Before the "check in wall station" or any check in exercise, the application required the insertion of a value referred to the perception of total self-recovery using the TQR only once per day. Moreover, the App UP150 was able to connect the mobile phone to all the training stations using QR codes that permitted access to the description of the exercise, the suggested time and subsequently to the timer attached to the selected activity. The timer stopped when the employees decided to push the stop button on the mobile phone and the score reached in physical activity performed (see section on Physical Activity Score) was shown automatically. The same sequence could be used even outside the office, in this case the employee had to select a category of exercise (cardiorespiratory fitness, muscular fitness, articular fitness, sports activity and combined fitness) and to decide when to activate and to stop the timer. The TD system inserted in the application permitted to record all training activity, to compare the reached score with the weekly goal score assigned by the PT, and to give information about the duration and the perceived intensity of the exercise performed. Pocket Trainer/Training Diary The pocket trainer (PT) and the training diary (TD) are two components of a unique tool that aim to control and improve the index of motor efficiency (IME, see Cubo Fitness Test section) and the participants' lifestyle by increasing physical activity, consciousness, and perception of their own psycho-physical condition. The PT assigns a goal score, dependent to the IME that has to be reached (or overpassed) during the week, performing different types of physical activity. The goal score is normalized based on the level of the participants. The minimum target score is 150 points (level C), the intermediate target score is

225 points (level B), while the maximum goal score is 300 points (level A) according to WHO recommendations (from 150 to 300 min of moderate physical activity Bull et al. 2020). Physical Activity Score The physical activity score (PAS) is an instrument that allows codifying and scoring the physical activity. It was necessary to allow the participants to reach the weekly goal score and record the physical activity performed inside and outside the office. The score is determined by the duration of exercise (in minutes) multiplied by an effort perception's coefficient. The coefficient is assigned as follows: the activities perceived from 0 to 3 (Light) on Borg's scale adapted from NSCA (2012) (Rikli and Jones 2013) are considered as coefficient 1; the activities perceived 4 or 5 (moderate) are considered as coefficient 1.5; and all the activities perceived 6 or more (vigorous) are considered as coefficient 2.

2.4.3. *Wellness Coaches*

The wellness coaches (Butterworth et al. 2006) were figures represented in this study by sport science graduate students. These specialists supported the employees during physical practice inside and outside the office. Furthermore, they personalized the exercises and the daily physical routine based on the employee's necessities (previous disease, injury or specific goal or necessity, based on CFT results). Moreover, their role consisted of making the employees aware of the benefits of good practices and healthy lifestyles. The coaches were available online 7 days per week and in office 2 days per week to demonstrate and to explain the correct execution of the exercises.

2.4.4. *Self-Determination Methodology*

The method used in this research followed the self-determination theory key points identified as the promotion of autonomy, competence, and relatedness (Deci and Ryan 2012). Autonomy is promoted thanks to the possibility of choosing the type (cardiorespiratory, muscular, flexibility or combined physical fitness), the place (inside or outside the office) and the duration and the intensity of the physical activity to reach an assigned target score using the PT and the TD instruments. Moreover, according to the considered literature, the architectural changes and the support of the application (App UP150) are thought to play an important role in autonomy promotion permitting to choose between many physical stations. Competence is guaranteed by the use of effort perception during physical activity. This method aimed to teach the employees how to practice physical fitness responsibly, respecting the participant's internal load and avoiding the risk of an inadequate intensity effort. Relatedness is promoted by encouraging the interaction with the wellness coaches and with the other employees during the active pauses or during breaks. Moreover, relatedness is encouraged by the specifically designed new architectural environment elements as meeting room's bike or break's room treadmill. To prevent the possible interference of the social context on the physical activity motivation and to enhance the perception of being socially connected (Manganelli et al. 2018), wellness coaches were fundamental to help the transition from the classic office concept to the present approach. The wellness coaches were asked to create an adequate working climate where physical activity during working time is not considered an embarrassing moment, but, conversely, a well-accepted opportunity by all colleagues.

2.5. Measures

2.5.1. *Cubo Fitness Test*

This test was administered to assess the physical levels of the employees in the office environment. The Cubo Fitness Test (CFT) (Invernizzi et al. 2021) is composed by 5 submaximal tests based on effort and pain perception executed on a cube-shaped multifunctional instrument. These tests propose to evaluate cardiorespiratory fitness, muscular fitness and flexibility fitness, related to physical wellness and maintaining good health (FitzGerald et al. 2004; Invernizzi et al. 2021; Micheo, Baerga, and Miranda 2012). Each test gives a defined number of points depending on the test result. The maximal reachable points for each test was chosen taking into account the importance of each considered fitness category in preventing health and mortality risks. Cardiorespiratory fitness has been demonstrated to be fundamental in preventing cardiovascular diseases and other comorbidities, including hypertension, diabetes, heart failure and atrial fibrillation (Al-Mallah H., Sakr, and Al-Qunaibet 2018), representing the major cause of death worldwide (Lopez et al. 2006; Organization 2002). A lower yet important contribution to health risk prevention is muscular fitness, which has been demonstrated to be efficient in reducing mortality risk (FitzGerald et al. 2004; Katzmarzyk and Craig 2002). Finally, flexibility fitness has been demonstrated to be effective in improving life quality (Cunha et al. 2008), but no researches have demonstrated its efficacy in mortality risk prevention. The index of motor efficiency (IME), resulting at the end of the five submaximal tests, ranges from 10 to 100 points. It summarizes the points reached in the 5 mentioned submaximal tests and was normalized based on age and sex. A score range lower than 33 points is considered a low level (level C), the score range included between 33 and 66 points is considered a medium level (level B) and the score range higher than 66 points is considered a high level (level A). The validity and the reliability of CFT were assessed in previous research (Invernizzi et al. 2021). In the following section, all 5 submaximal tests are explained.

Ruffier test (RT) (G Papini et al. 2017): The participants had to sit and stand up from the cube with a frequency of 40 bpm for 30 times (or 45 s). During the test, we collected the resting hearth rate (HR0), the hearth rate (HR) immediately at the end of test (HR1) and the HR one minute after the end (HR2). The Ruffier index (RI) was calculated using the following formula:

RI = (HR0 + HR1 + HR2 - 200)/100.

Lower values of RI indicate a better performance. The height of the sitting position was modified using supports appropriately designed to maintain a 90 degrees knee angle for each participant during the sitting activity. The effort perception was requested at the end of the test using the adapted Borg's CR-10 scale (Rikli and Jones 2013). The maximal acquirable score was 40 points.

Thirty second push-up test (PUT) (Crotti et al. 2018; Invernizzi et al. 2020): The participants had to choose one of three difficulty levels in order to obtain an effort perception of "moderate" on the adapted Borg's CR-10 scale. The levels were defined by the different distances from the ground where the hands' support. Level 3 was the easiest (120 cm from the ground), followed by level 2 (60 cm from the ground) and level 1 (40 cm from the ground). After choosing, the test required the performance of the maximum possible number of push-ups in 30 s, with the subsequent assessment of target effort perception at the end of the test. The maximal acquirable score was 20 points.

Thirty second seated sit-up test (SUT) (Crotti et al. 2018; Invernizzi et al. 2020): The participant had to choose one of three difficulty levels in order to obtain an effort perception of "moderate" on the adapted Borg's CR-10 scale. The levels were defined by a different inclination of the seat's back support. Similar to the PUT, Level 3 was the easiest (90° of inclination), followed by level 2 (45 of inclination) and level 1 (15 of inclination). The participant was requested to sit at the edge of the sitting area and to perform the maximum possible number of seated sit-ups in 30 s, with the subsequent assessment of target effort perception at the end of the test. The maximal acquirable score was 20 points.

Shoulder mobility test (SMT) (Harre 1977): The main tool of this test is a graduated stick. This instrument is marked with a precise measurement in centimeters starting from 0 in the middle point and increasing the measurement in equal increments in both directions. The participant had to hold the stick with both hands at the same distance from point 0. Starting with a large distance, participants had to perform a backward and subsequently a forward circle with upper limbs extended without losing grip. The participants were asked to repeat the test gradually reducing the hands distance, until they reached their limit without pain perception (value 100 of SIS scale Freitas et al. 2015). The maximal acquirable score was 10 points.

Chair sit and reach test (SRT) (Jones et al. 1998): The participant was asked to sit on the cube at the edge of the sitting area similarly to the SUT and to lay one leg on the graduated board while the other one was bent with an angle of 90° and with the foot on the ground. The centimeter placed on the graduated board was calibrated, making the point 0 to start next to the participant's heel. Starting from this point, the centimeter presents two ranges of values: a positive one from heel to the ground and a negative one from heel to the participant's hip. The participant was asked to slowly bend over (5 s) trying to reach or to overpass the heel with both hands performing the maximum stretching without pain (value 100 of SIS scale Freitas et al. 2015), holding the position for 2 s while the evaluator measured the distance in centimeters from the hands' middle fingers to the heel and subsequently to return in 5 s. The same measurement was performed for both of legs and the points were assigned using the mean value. The maximal acquirable score was 10 points.

2.5.2. Questionnaires

International Physical Activity Questionnaire (IPAQ)

The IPAQ is a validated questionnaire that estimates the amount and the intensity of weekly physical activity performed by adults between 18 and 65 years old (Craig et al. 2003). The questionnaire consists of 9 questions from which it was possible to obtain a score in Met referred to total activities. Moreover, thanks to the questionnaire, it was possible to estimate the weekly minutes elapsed in sedentary behavior (during working week and during weekend) or in light, moderate and vigorous physical activity. According to the literature, a total score lower than 700 Met was considered as inactive, a total score from 700 to 2519 Met was considered as active and a score up to 2519 Met was considered very active.

NASA Task Load Index (NASA-TLX)

The NASA-TLX is an evaluation instrument useful to investigate a perceived workload referred to a specific activity (Hart 2006; Hart and Staveland 1988). In the present research, it was requested to evaluate the workload referred to the previous working week (Hoonakker et al. 2011). The questionnaire permitted to evaluate 6 perceived loads: the mental demand (MD), the physical demand (PD), the temporal demand (TD), the effort (EF), the performance (PE) and the frustration (FR). Moreover, a total score (TS) summarized the overall workload. Short Form Healthy Survey (SF-12) The SF-12 is a validated questionnaire that aims to evaluate the psycho-physical health status of the participants (Kodraliu et al. 2001). It is a short version of SF-36 and consist of 12 questions. The SF-12 permits to estimate the self-reported health status by evaluating two indexes, identified as the physical component summary (PCS-12) and the mental component summary (MCS-12). The survey presents six questions that investigate the PCS-12 through physical activity, the limitations due to physical health, physical pain and general health, while six questions investigate the MCS-12 through social activities, vitality, emotional status and mental health.

2.5.3. Accelerometers

In the present research, the triaxial accelerometers Axivity AX3 (Axivity Ltd., Newcastle upon Tyne, UK, 2013) were used in order to assess the amount of sedentary (lower than 1.5 Met), light (from 1.5 to 3 Met), moderate (from 3 to 6 Met) and vigorous (up to 6 Met) physical activities of the employees according to the literature (Arvidsson et al. 2019). The accelerometers' measurements had a range of recorded acceleration of 16 g and data were collected with a frequency of 100 Hz (Doherty et al. 2017). The accelerometers were worn on the wrist of the non-dominant hand (Dieu et al. 2017) from Monday to Friday; the raw triaxial data were downloaded from the devices and exported using OmGUI software version 1.24 (Axivity Ltd., Newcastle upon Tyne,UK, 2013).

2.5.4. Total Quality Recovery Scale (TQR)

In the present research, the TQR was proposed to evaluate the perceived recovery status of the employee before performing the CFT and during the entire working week. It is a validated scale that permits to evaluate the psycho-physical recovery referred to the last 24 h (Renttä and Hassmén 1998). The TQR is composed by a range of value from 6 (very, very poor recovery) to 20 (very, very good recovery). The participant had to focus on his own recovery perception and, based on the scale's verbal anchor, to give the most adequate value. The range of values from 12 to 14 (reasonable recovery) was considered adequate to perform the CFT.

2.5.5. Training Load

Both the EG and CG were asked daily to record their effort perception, based on the adapted Borg's scale, referring to the performed working hours. The training load was calculated by multiplying the effort perception reported by the working minutes performed (Foster et al. 1996).

2.6. Statistical Analysis

The normal distribution of data was conducted using the Kolmogorov–Smirnov test. The reliability of the CFT was assessed through the interclass correlation coefficient (ICC). The homogeneity of the analyzed groups was assessed by performing the unpaired t test or the respective non-parametric Mann–Whitney U test. To verify the efficacy of the intervention, an ANOVA 3 X 2 (pre/post/retention X EG/CG) was performed for the CFT and IPAQ data, while an ANOVA 2 X 2 (pre/post EG/CG) was performed for the NASA-TLX and SF-12 data. When a non-parametric analysis occurred, a Friedman test (to assess the intra-group differences) with a Mann–Whitney U test (to assess the inter-group differences) was chosen to replace the ANOVA 3 X 2, while theWilcoxon test (to assess the intra-group differences) with the Mann–Whitney U test (to assess the intergroup differences) was chosen to replace the ANOVA 2 X 2. The delta values (pre-post) differences for each variable between the EG and CG groups were analyzed and compared using the unpaired t-test or the respective Mann–Whitney U test. To analyze the accelerometer data, an ANOVA 4 X 2 (detection X EG/CG) was performed, while a Friedman test (to assess the intra-group differences) with a Mann–Whitney U test (to assess the inter-group differences) was chosen for the non-normally distributed data. During the three weeks of training of the experimental group, an ANOVA 3 X 2 (detection X condition) was used to assess differences in amounts of minutes of exercise during each of the three detections of training for the accelerometer and pocket trainer measurements of the intensity of the exercise. The independent sample t-test or respective Mann–Whitney U test was used to detect differences between the minutes and scores of physical activities performed inside and outside the office measured with the training diary. Significance was set at 0.05 (2-tailed) for all analyses. To analyze the TQR and the training load data, an ANOVA 8 X 2 (evaluated weeks X EG/CG) was performed, while a Friedman test (to assess the intra-group differences) with a Mann–Whitney U test (to assess the inter-group differences) was chosen for the nonnormally distributed data. The effect sizes for the repeated measurements using ANOVA were calculated as partial eta squared (η^2), using the small = 0.02, medium = 0.13 and large = 0.26 interpretation for effect size (Bakeman 2005). The effect size for the Mann–Whitney U test and Wilcoxon test was calculated as Pearson's r, using the small = 0.1, medium = 0.3 and large = 0.5 interpretation of the effect size (Cohen 2013). Moreover, the effect size for the Friedman analysis was calculated using Kendall'sW(W), using the small = 0.1, medium = 0.3 and large = 0.5 interpretation of the effect size (Cohen 2013). All data analysis was conducted using the statistical packages for social sciences (SPSS version 21).

3. Results

3.1. CFT

All CFT tests results are shown in Table 1, while the CFT's reliability data and the CFT's RPE data are shown in Appendix A Tables A1 and A2. CFT was found reliable for all its variables, and RPE measured in each test of CFT did not show any significative difference in between and within group analysis ($p > 0.05$). Table 1. Results of CFT test performed before the intervention (pre), at the end of the intervention (post) and 4 weeks after the end of the intervention (retention).

Table 1. Results of CFT test performed before the intervention (pre), at the end of the intervention (post) and 4 weeks after the end of the intervention (retention).

		Pre	Post	Retention	Delta 1	Delta 2
Ruffier (AU)	EG	13.1 ± 4.5	10.2 ± 16.2 #	9.9 ± 3.1	3.4 ± 2.2	0.3 ± 2.4
	CG	14.0 ± 5.2	11.2 ± 10.8 #	11.0 ± 3.6	2.8 ± 4	0.4 ± 3.6
30 s Push-up (AU)	EG	3.5 ± 1.9	6.6 ± 11.6 #	5.41 ± 3.1	3.1 ± 2.9	0.6 ± 3.1
	CG	3.2 ± 1.1	6.1 ± 10.0 #	5.7 ± 2.4	2.9 ± 2.5	0.4 ± 2.6
30 s Seated Sit-Up (AU)	EG	6.3 ± 3.2	9.4 ± 3.1 #	7.8 ± 4.2	3.3 ± 3.2 *	0.3 ± 2.6
	CG	7.0 ± 3.4	8.8 ± 4.0	9.6 ± 3.7	1.0 ± 2.4	1.0 ± 3.2
Shoulder mobility (cm)	EG	52.4 ± 9.8	44.0 ± 4.7 #	46.8 ± 9.3	7.6 ± 5.8 *	2.2 ± 4.7 *
	CG	49.3 ± 8.4	47.0 ± 3.0	47.5 ± 8.4	0.5 ± 3.7	1.2 ± 3.6
Chair sit and reach (cm)	EG	−5.0 ± 13.0	−0.8 ± 10.0 #	−2.5 ± 13.6	5.0 ± 7.2 *	4.6 ± 5.4 *
	CG	−0.4 ± 10.9	1.4 ± 11.6	−2.2 ± 12.2	1.2 ± 3.6	0.5 ± 3.7
Index of Motor Efficiency (AU)	EG	29.4 ± 13.7	43.0 ± 2.3 #	39.4 ± 16.4	14.4 ± 8.7 *	3.8 ± 8.4
	CG	32.2 ± 11.7	36.0 ± 2.6	37.4 ± 12.5	3.1 ± 10.5	3.0 ± 10.1

* = significant p-value (<0.05) in between groups analysis (EG vs. CG); # = significant p-value (<0.05) in within group analysis (pre vs. post vs. retention). Delta 1 is calculated with post–pre, while delta 2 with retention–post. Data are shown as mean _ standard deviation. Data of delta 1 and delta 2 are expressed in absolute values.

3.1.1. IME

The index of motor efficiency test showed a significant interaction group by time ($p = 0.008$, $\eta^2 = 0.141$), a significant main effect of time ($p < 0.001$, $\eta^2 = 0.351$) and no significant main effect of group. Follow up tests revealed that, while the control group did not change over time from pre to post and from post to retention, the experimental group showed a significant increase in the test from pre to post ($p < 0.001$) and from pre to retention ($p < 0.001$), while no significant differences were found from post to retention, although there was a trend toward significance ($p = 0.074$). The analysis of the deltas showed a significant difference between groups regarding delta of the pre-post test ($p < 0.001$) and a trend to significance in the post–retention test ($p = 0.052$). Figure 2 shows the main results of IME.

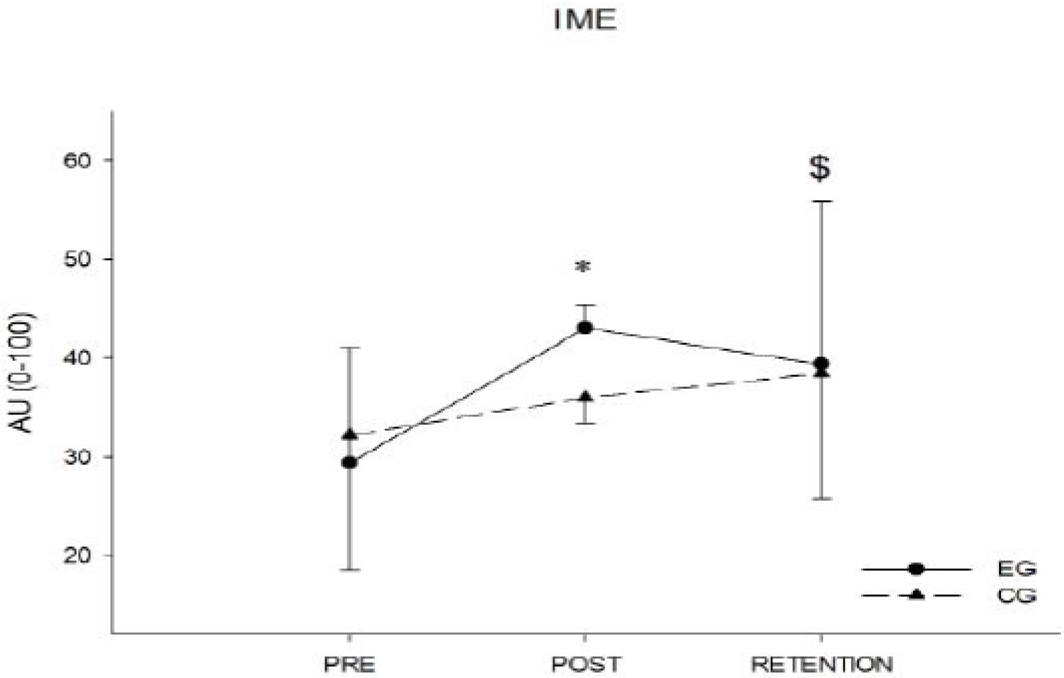


Figure 2. Index of motor efficiency analysis in the pre-post and retention phases. * = significant p-value (<0.05) in between groups analysis (EG vs. CG); $ = significant p-value (<0.05) in within EG analysis (pre vs. post vs. retention).

3.1.2. SMT

The shoulder mobility test showed a significant interaction group by time ($p < 0.001$, $\eta^2 = 0.243$), a significant main effect of time ($p < 0.001$, $\eta^2 = 0.299$) and no significant main effect of group. Follow up tests revealed that, while in the control group the shoulder mobility did not change over time from pre to post to retention, the experimental group showed a significant difference in the test from pre to post ($p < 0.001$) and from post to retention ($p = 0.017$). The analysis of the deltas showed a significant difference between groups regarding delta of the pre-post-test ($p < 0.001$) and post–retention test ($p = 0.034$). All participants reported a value of SIS scale of 100, which corresponds to the maximum stretching without pain as requested.

3.1.3. SRT

In the chair sit and reach test, a significant difference with the Friedman test ($\chi^2(2) = 13.164$, $p < 0.001$, $W = 0.32$) was found in the experimental group among the three different conditions (pre, post and retention). Follow up tests with Wilcoxon signed rank tests showed that there was a significant difference between pre and post conditions ($Z = -3.024$, $p = 0.002$, $r = 0.67$) and between post and retention condition ($Z = -3.182$, $p = 0.001$, $r = 0.71$). In the control group, no significant difference was found with the Friedman test. Mann– Whitney U test at post intervention showed no significant difference between groups. The analysis of the deltas showed a significant difference between groups regarding the delta of the pre-post test ($Z = -3.981$, $p < 0.00,1$, $r = 0.62$) and a significant difference in the post–retention test ($Z = -2.217$, $p < 0.027$, $r = 0.62$). All participants reported a value of SIS scale of 100, which corresponds to the maximum stretching without pain as requested.

3.1.4. SUT

In the sit-up test, a significant difference with the Friedman test ($\chi^2(2) = 10.107$, $p = 0.006$, $W = 0.25$) was found in the experimental group among the three different conditions (pre, post and retention). Follow up tests with Wilcoxon signed rank tests showed that there was a significant difference between pre and post conditions ($Z = -3.268$, $p = 0.001$, $r = 0,75$), while no significant difference was observed between post and retention conditions. In the control group, no significant difference was found with the Friedman test. Mann–Whitney U test at post intervention showed no significant difference between groups. The analysis of the deltas showed a significant difference ($Z = -2.427$, $p = 0.015$, $r = 0.38$) between groups regarding the delta of the pre-post test. No significant difference was found for the post–retention test. The RPE measured for the sit-up test at pre, post and retention did not show any significant differences over time and between groups.

3.1.5. PUT

In the push up test, a significant difference with the Friedman test ($\chi^2(2) = 11.414$, $p = 0.003$, $W = 0.33$) was found in the experimental group among the three different conditions (pre, post and retention). Follow up tests with Wilcoxon signed rank tests showed a significant difference between pre and post conditions ($Z = -3.361$, $p = 0.001$, $r = 0.75$), while no significant difference was observed between post and retention conditions. In the control group, a significant difference was found with the Friedman test ($\chi^2(2) = 17.492$, $p < 0.001$, $W = 0.51$). Follow up tests with Wilcoxon signed rank tests showed a significant difference between pre and post conditions ($Z = -3.420$, $p < 0.001$, $r = 0.76$), while no significant difference was observed between post and retention conditions. Mann–Whitney U test at post intervention showed no significant difference between groups. The analysis of the deltas showed no significant differences between groups regarding the delta of the pre-post test and post–retention test. The RPE measured for the push up test at pre, post and retention did not show any significant interaction or main effects.

3.1.6. RT

The Ruffier test did not show any significant interaction group by time or main effect of group. However, a main effect of time was detected ($p < 0.001$, $\eta^2 = 0.404$). The Ruffier index decreased from pre to post ($p < 0.001$) with no differences between groups; however, it did not change between post and retention. The analysis of the deltas showed no significant differences between groups regarding the delta of the pre-post test and post–retention test. The RPE measured for the Ruffier test at pre, post and retention did not show any significant interaction or main effects.

3.2. Questionnaires

3.2.1. IPAQ

No differences were found with the Friedman test in both groups for the physical activity questionnaire in any of the analyzed variables: total met, sedentary behavior during the weekend, sedentary behavior during the week, and light, moderate and vigorous physical activity. However, the

Mann–Whitney U test revealed a significance for retention's total Met values (Z = 1.986, p = 0.049, r = 0.31) and for post–retention delta's light activities (Z = 2.222, p = 0.026, r = 0.35). All IPAQ data are shown in Table 2.

Table 2. Results of IPAQ performed before the intervention (pre), at the end of the intervention (post) and 4 weeks after the end of the intervention (retention).

			Pre	Post	Retention	Delta 1	Delta 2
IPAQ	Vigorous Activity (Met)	EG	822.9 ± 1182.3	802 ± 1047.1	1294.1 ± 1729.8	34.0 ± 871.7	501.2 ± 1290.7
		CG	830.5 ± 789.8	1302.2 ± 1060.5	1793.7 ± 1854.5	377.8 ± 1311.6	562.4 ± 2150.7
	Moderate activity (Met)	EG	701.0 ± 1105.8	859.2 ± 1320.6	828.2 ± 1512.7	147.2 ± 706.1	140.0 ± 1905.2
		CG	634.3 ± 795.2	377.8 ± 261.8	818.9 ± 966.1	238.9 ± 819.4	430.6 ± 1033.4
	Walking activity (Met)	EG	1604.6 ± 3145.3	1672.4 ± 3788.3	657.5 ± 720.4	40.0 ± 1235.5	1116.5 ± 3486.7 *
		CG	754.9 ± 720.4	815.4 ± 565.3	1211 ± 1086.7	12.8 ± 905.1	437.2 ± 1017.3
	Sedentary activity during working day (Met)	EG	506.8 ± 166.1	432.5 ± 188.0	411.8 ± 228.5	72.5 ± 154.8	15.9 ± 156.8
		CG	488.1 ± 150.3	450.0 ± 137.4	429.5 ± 186.6	42.8 ± 168.6	28.2 ± 120.6
	Sedentary activity during weekend (Met)	EG	184.3 ± 103.7	153.3 ± 122.0	144.7 ± 108.9	34.3 ± 119.1	6.2 ± 123.3
		CG	233.8 ± 188.1	216.7 ± 204.7	162.1 ± 105.3	29.4 ± 284.4	63.5 ± 188.2
	Total (Met)	EG	3128.5 ± 4781.4	3333.6 ± 5250.0	2779.8 ± 3332.9 *	221.2 ± 1785.4	755.3 ± 4721.0
		CG	2219.6 ± 1708.1	2495.4 ± 1301.2	3823.6 ± 2574.1	126.1 ± 1711.7	1430.1 ± 3023.0

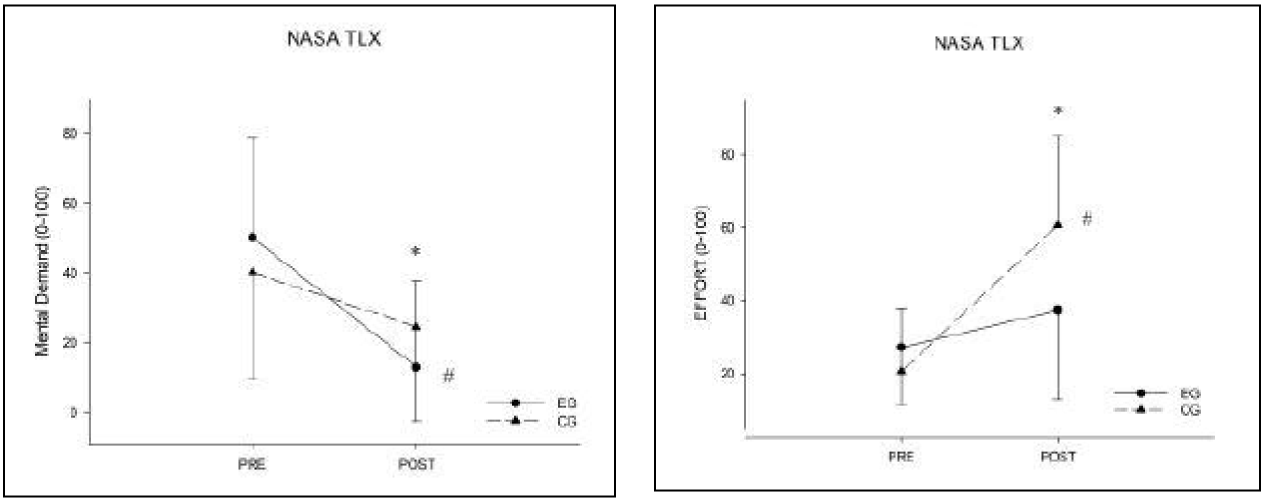
EG = experimental group; CG = control group. * = significant p-value (<0.05) in between groups analysis (EG vs. CG). Data are shown as mean ± standard deviation. Delta 1 is calculated with post–pre, while delta 2 with retention–post. Data of delta are expressed in absolute values.

3.2.2. NASA-TLX

No significant interactions or main effects were found for temporal demand, frustration and the total score that summarized the total workload. The physical demand increased significantly (experimental: Z = -2.894, p = 0.004, r = 0.65; control: Z = -2.897, p = 0.004, r = 0.65) from pre to post uniformly with no differences in the groups. The Mann–Whitney U test revealed that there is no significant difference between groups at pre and at post. The delta analysis did not show any significant differences between the groups. For the performance scale, Wilcoxon signed rank tests showed a significance difference between pre and post for the control group (Z = -3.508, p < 0.001, r = 0.78), while no differences were reported for the experimental group. The Mann–Whitney U test revealed a significant difference (Z = -2.192, p = 0.028, r = 0.34) between the groups at pre-test, while no significant difference between groups was detected at post-test. The delta analysis showed a significant difference in performance (Z = -2.882, p = 0.003, r = 0.46) between the two groups. For the mental demand scale, Wilcoxon signed rank tests showed a significance difference between pre and post for the experimental group (Z = -2.913, p = 0.004, r = 0.65), while no differences were reported for the control group. The Mann–Whitney U test revealed a significant difference (Z = -2.041, p = 0.047, r = 0.32) between the groups at post-test, while no significant difference between groups was detected at pre-test. Delta analysis showed a trend toward significant difference (Z = -1.726, p = 0.087, r = 0.27) between the two groups. For the effort scale, Wilcoxon signed rank tests showed a significance difference between pre and post for the control group (Z = -3.463, p < 0.001, r = 0.77), while no differences were reported for the experimental group. The Mann–Whitney U test revealed a significant difference (Z = -2.663, p = 0.007, r = 0.42) between the groups at post-test, while no significant difference between groups was detected at pre-test. The delta analysis showed a significant difference in effort (Z = -3.246, p = 0.001, r = 0.51) between the two groups. Figure 3 shows the effort and mental demand results. All NASA-TLX data are shown in Table 3.

3.2.3. SF-12

The health questionnaire did not report any significant interaction (group by time) or main effects for the physical component (PCS). Regarding the mental component, a trend to interaction was found (p = 0.087, 2 = 0.070) and a significant main effect of time (p = 0.03, 2 = 0.154) was reported. The delta analysis showed a significant difference in the mental component (MCS) (Z = -2.102, p = 0.036, r = 0.33) between the two groups. SF-12 data are shown in Table 3.



(a) (b)

Figure 3. NASA-TLX analysis in the pre and post phases. (**a**) Analysis of effort; (**b**) analysis of mental demand. * = significant p-value (<0.05) in between groups analysis (EG vs. CG); # = significant p-value (<0.05) in within group analysis (pre vs. post).

Table 3. Results of the NASA-TLX and SF-12 questionnaires performed before the intervention (pre) and at the end of the intervention (post).

			Pre	Post	Delta 1
NASA-TLX	Mental Demand	EG	50.3 ± 28.5	13.0 ± 24.9 # *	36.1 ± 44.5
		CG	40.3 ± 30.7	24.6 ± 27.0	15.9 ± 41.1
	Physical Demand	EG	8.6 ± 16.6	24.3 ± 21.5 #	15.3 ± 25.0
		CG	5.7 ± 9.0	19.1 ± 20.9 #	15.6 ± 18.8
	Temporal Demand	EG	44.7 ± 27.3	55.5 ± 20.0	11.2 ± 32.6
		CG	45.2 ± 25.5	49.2 ± 23.8	7.1 ± 29.1
	Performance	EG	22.0 ± 13.7 *	19.0 ± 21.1	2.8 ± 23.7 *
		CG	32.8 ± 18.3	9.7 ± 12.7 #	24.9 ± 19.1
	Effort	EG	27.2 ± 15.7	37.3 ± 24.4 *	9.0 ± 30.4 *
		CG	20.6 ± 17.1	60.6 ± 24.6 #	43.4 ± 29.9
	Frustration	EG	29.7 ± 35.2	34.8 ± 24.7	4.1 ± 35.5
		CG	27.2 ± 33.1	34.7 ± 23.5	11.2 ± 34.4
	Weighted sum	EG	12.2 ± 4.1	12.3 ± 2.8	15.3 ± 25
		CG	11.5 ± 4.3	13.2 ± 3.9	15.6 ± 18.8
SF-12	PCS12	EG	53.5 ± 7.2	55.3 ± 5.2	1.8 ± 6.3
		CG	56.1 ± 5.4	54.7 ± 5.7	1.4 ± 7.0
	MCS12	EG	37.5 ± 9.8	46.6 ± 8.2 #	9.1 ± 8.0 *
		CG	39.2 ± 9.0	42.3 ± 12.2 #	3.1 ± 13.5

* = significant p-value (<0.05) in between groups analysis (EG vs. CG); # = significant p-value (<0.05) in within group analysis (pre vs. post). EG = experimental group; CG = control group. Data are shown as mean ± standard deviation. Delta 1 is calculated with post–pre. Data of delta are expressed in absolute values.

3.3. Accelerometers

The accelerometers data are shown in Table 4. No significant differences among weeks and for both groups were found for sedentary, light and vigorous minutes of exercises. No significant difference was found for the control group for moderate exercise among the four detections. A significant difference was found for moderate minutes of exercise in the experimental group among the four detections with the Friedman test ($\chi^2(3) = 18.200$, $p < 0.001$, $W = 0.30$). Follow up tests with Wilcoxon signed rank tests showed that the first detection was significantly different from detection 2 (Z = -2.215, p = 0.027, r = 0.50), detection 3 (Z = -2.605, p = 0.009, r = 0.58) and detection 4 (Z = -2.668, p = 0.008, r = 0.60), while detection 2 was significantly different from detection 3 (Z = -2.012, p = 0.044, r = 0.31) and detection 4 (Z = -1.961, p = 0.050, r = 0.31). No significant difference was found between detections 3 and 4. The Mann–Whitney U test did not show any significant inter group difference between the experimental and control groups for sedentary, light and vigorous minutes of exercise. However, in the moderate minutes category, a significant difference between the groups was found at detection 2 (Z = -2.336, p = 0.018). No other group differences were found in any other detection.

Table 4. The outcomes of the accelerometers used in the intervention.

		CG	EG
Intensity		Mean ± SD	Mean ± SD
Sedentary minutes	Detection 1	2334.5 ± 321.4	2442.2 ± 252.6
	Detection 2	2353.5 ± 165.0	2309.2 ± 331.6
	Detection 3	2317.3 ± 294.7	2343.9 ± 262.4
	Detection 4	2382.3 ± 272.5	2332.4 ± 269.6
Light minutes	Detection 1	209.0 ± 55.0	177.2 ± 51.8
	Detection 2	200.3 ± 56.3	189.6 ± 55.7
	Detection 3	212.1 ± 55.8	202.1 ± 65.9
	Detection 4	221.8 ± 46.8	208 ± 51.5
Moderate minutes	Detection 1	300.9 ± 139.0	307.8 ± 176.7
	Detection 2	281.7 ± 171.6	355.4 ± 124.8 #*
	Detection 3	345.9 ± 200.6	392.9 ± 153.7 #§
	Detection 4	314.7 ± 117.3	425.4 ± 175.9 #§
Vigorous minutes	Detection 1	10.3 ± 20.3	6.1 ± 13.1
	Detection 2	6.6 ± 13.6	3.7 ± 5.0
	Detection 3	8.1 ± 12.1	4.5 ± 6.5
	Detection 4	7.3 ± 8.8	4.2 ± 5.5

EG = experimental groups; CG = control group. Detection 1 represents the pre-assessment; detection 2 represents the first measurement during the intervention; detection 3 represents the second measurement; detection 4 represents the third measurement during the intervention. * = significant p-value (<0.05) in between groups analysis (EG vs. CG); # = significant p-value (<0.05) in within group analysis (difference with detection 1); § = significant p-value (<0.05) in withing group analysis (difference with detection 2).

3.4. App UP150 (Experimental Group Procedures)

3.4.1. Pocket Trainer vs. Accelerometer

No significant interaction or main effects were reported for the number of minutes during the three detections for the accelerometer and PT measurement of vigorous training. For light training, ANOVA revealed a significant main effect of condition ($p = 0.046$, $\eta^2 = 0.4090$), showing that the experimental group reported in the PT more minutes in the light difficulty training (308.6 ± 201.9) than what the accelerometer index confirmed (187.5 ± 41.4). Contrary to that, in the moderate training, ANOVA detected a significant main effect of condition ($p = 0.004$, $\eta^2 = 0.674$), showing that subjects in the experimental group reported less minutes in the moderate difficulty training (125.2 ± 110.2) compared to what the accelerometer index confirmed (427.7 ± 176.2). The results are reported in Table 5.

3.4.2. Training Diary

From Table 6, it is possible to extrapolate that most of the exercises performed belonged to cardiorespiratory fitness (80% of the weekly activity), followed by muscular (9% of the weekly activity) and combined (9% of the weekly activity) fitness, while the less approached was the flexibility fitness (2% of the weekly activity). Nevertheless, flexibility fitness was practiced more inside the office than outside (59% vs. 41%), even without significant differences, while all other typologies of fitness were practiced more outside than inside the office (cardiorespiratory: 32% inside office, 68% outside; muscular: 29% inside office, 71% outside; combined: 25% inside office, 75% outside).

Table 5. The outcomes of the App UP150 - Pocket Trainer used in the intervention.

	Accelerometer	PT	EG—Accelerometer	EG—PT
Intensity			Mean ± SD	Mean ± SD
Light minutes	Detection 2	Detection 1	189.6 ± 55.7	326.9 ± 248.1 *
	Detection 3	Detection 2	202.1 ± 65.9	342.1 ± 175.7 *
	Detection 4	Detection 3	208 ± 51.5	316.8 ± 199 *
Moderate minutes	Detection 2	Detection 1	355.4 ± 124.8	127.9 ± 139.8 *
	Detection 3	Detection 2	392.9 ± 153.7	118.8 ± 82.3 *
	Detection 4	Detection 3	425.4 ± 175.9	74.9 ± 80.9 *
Vigorous minutes	Detection 2	Detection 1	3.7 ± 5.0	15 ± 21.9
	Detection 3	Detection 2	4.5 ± 6.5	25 ± 50.4
	Detection 4	Detection 3	4.2 ± 5.5	27.4 ± 72.3

Data are shown as mean _ standard deviation. PT's Detection 1 corresponds to the first measurement performed with the accelerometer during the second phase (detection 2); PT's detection 2 represents the second measurement performed with the accelerometer (detection 3); PT's detection 3 represents the third measurement (detection 4). The PT measurements shown represent the minutes of activity perceived as light, moderate and vigorous and reported in the App UP150 by the EG. * = significant p-value (<0.05) in between groups analysis (PT vs. accelerometer).

Table 6. App UP150 - Training diary mean outcomes.

App UP150—Training Diary (Mean ± SD)			
	Total	Inside Office	Outside Office
Cardiorespiratory Fitness (Min)	314.9 ± 103.6	99.6 ± 59.0	214.8 ± 110.5 *
Muscular Fitness (Min)	35.1 ± 52.8	10.2 ± 7.8	25.0 ± 52.2
Flexibility Fitness (Min)	8.3 ± 8.5	4.9 ± 4.2	3.4 ± 5.4
Combined Fitness (Min)	35.2 ± 46.7	8.9 ± 7.0	26.3 ± 44.2
Total (Min)	394.8 ± 132.6	124.2 ± 65.6	269.9 ± 149.4 *
Cardiorespiratory Fitness (Points)	346.8 ± 103.7	112.3 ± 61.8	233.9 ± 115.4 *
Muscular Fitness (Points)	47.9 ± 70.2	13.0 ± 9.7	34.8 ± 70.3
Flexibility Fitness (Points)	9.2 ± 9.4	5.5 ± 4.8	3.7 ± 6.0
Combined Fitness (Points)	62.1 ± 73.4	12.7 ± 12.7	49.4 ± 68.8 *
Total score (Points)	467.3 ± 149.9	144.2 ± 74.4	322.3 ± 175.6 *
Target score (Points)	191.9 ± 29.7		

Data refer to the mean weekly number of minutes and points accumulated. The table shown data refer to physical activity performed inside the office (inside office), outside the office (outside office) and the total physical activity obtained summed the inside and the outside office activities. * = significant p-value (<0.05) in between groups analysis (inside office vs. outside office).

3.5. TQR

No significant interaction or main effects were reported for the total quality recovery scale. All TQR data are reported in Appendix A Table A3.

3.6. Training Load

No significant interaction or main effects were reported for the training load. All training load data are reported in Appendix A Table A3.

4. Discussion

4.1. Cubo Fitness Test

Based on the present data and comparing with the previous literature, CFT data were found reliable according to previous research (Invernizzi et al. 2021). No differences were found in RPE values measured after each test of CFT, confirming the accuracy of the CFT instrument in performing measurements. Analyzing the test results, CFT shows the efficacy of the intervention in the improvement of the level of IME. The EG passed from a low level (29.4 ± 13.7 a.u.) to a medium level (43.0 ± 15.6 a.u.). Consequently, it is reasonable to assert that the intervention has demonstrated efficacy in improving the EG's general physical condition according to the multi-factorial intervention proposed by Maylor and colleagues (Maylor et al. 2018). As explained previously, the IME is the final CFT score, composed by the sum of the individual submaximal tests' scores, and it is necessary to analyze the components that contributed to the overall improvement. The intervention significantly increased the levels of flexibility fitness (SMT and SRT) and muscular fitness (SUT). Considering flexibility fitness, the intervention improved both SMT and SRT in the EG, while the CG maintained the initial levels of flexibility. This effect could be due not only by the time spent performing flexibility exercises, but even by the concomitance of more factors, such as combined fitness (where a combination of muscular and flexibility fitness occurred) and muscular fitness (Santos et al. 2010). In particular, muscular fitness has been demonstrated to have efficacy in improving flexibility when different muscle groups are involved alternatively (Santos et al. 2010). Indeed, during the intervention, employees could freely approach different muscular exercises in the office and combined fitness permitted to increase the total amount of time spent performing activities related to flexibility fitness. Analyzing the results of muscular fitness, the SUT showed an improvement in abdominal strength only for the EG. In the literature, it is well explained how the specific exercise of sit-up offers better results in the sit-up test than other exercises (curl-up or core stability exercises) (Baxter et al. 2003; Childs et al. 2009). From this point of view, the improvement in the SUT could be explained by the specificity of some exercises performed by the EG; indeed, sit-ups were one of the exercises proposed to the employees of the EG during the office intervention. Differently, the results of PUT reported an increase in upper-limb muscular fitness for both groups. It should be noted that the intervention started soon before the end of the Italian lockdown restrictions for the SARS-CoV-2 pandemic (the intervention started 7 May 2021, while the main restrictions finished 24 May 2021). The reopening of gyms and sport centers could have permitted the improvement in some kind of fitness levels even in the control group. In particular, the push-ups could be defined as a commonly prescribed exercise that were recommended even to the computer worker population during the COVID-19 quarantine (Shariat et al. 2020). For this reason, PUT could have been influenced by a "background noise" that could have hidden the intervention efficacy. Even if both the EG and CG improved their cardiovascular fitness results, the intervention was not able to create differences between the two groups. The lack of differences could be explained by the duration of the intervention and the intensity of the performed exercises. A meta-analysis of Boulè and colleagues (Boulé et al. 2003) considered eight weeks of cardiorespiratory training intervention as the minimum inclusion criteria. Nevertheless, the duration of the intervention program of the present research seems not enough to see more significant differences in the cardiorespiratory fitness of the EG employees. Even in this case, the lack of a significant difference between the two groups could be due, as described for PUT, to the end of the lockdown, which could have motivated even the CG to engage in more physical activity after a prolonged period of restrictions. Nevertheless, data presented in the researches of Branch and colleagues, and Dunn and colleagues (Branch, Pate, and Bourque 2000; Dunn et al. 1999) showed that, at moderate intensity, marked results in cardiorespiratory fitness could be obtained after a wider period of training (12–24 weeks); considering the current pandemic situation, extending the period of intervention of the present study could bring more marked results. Analyzing the retention effects, the employees of EG maintained the new acquired level of IME. Analyzing the results of the five submaximal fitness tests, the EG retained the values of RT, PUT and SUT, while the values of SMT and SRT decreased. The results seem to agree with the research conducted by Chen and colleagues (Chen et al. 2017) that showed how different types of exercises could provide different effects after an intervention of 8 weeks and a successive rest of 4 weeks. In particular, the resistance and aerobic exercises seem to be efficient in maintaining positive effects after a period of interruption of the activities (the considered intervention included 2 days of training per week). The loss of flexibility could find explanation in the interruption of the stress-reduction effect promoted by the intervention (Kopp et al. 2008). Indeed, the results of our study demonstrated that the intervention reduced the perception of mental demand and improved the perceived mental health; all these factors could be considered as clues of the anti-stress effect of the intervention (Kopp et al. 2008; Taelman et al. 2008). The absence of the intervention during the 4 weeks that followed the study could have contributed to increase the related muscular tone stress, as shown in a research based on visual display workers (Wahlström et al. 2003) and, consequently, could have reduced flexibility fitness.

4.2. Questionnaires

The proposed questionnaires highlight a positive effect of the UP150 on the mental psycho-physical components. Based on the significances found in the effort variable of the NASA-TLX, it can be concluded that the amount of practiced physical activities and, more in general, the intervention had a contribution to maintain the initial level of working effort perception conversely to CG, which increased the weekly working effort perception in the last period of training. This could be caused by the coping effect of the physical exercise during working hours (Faulkner et al. 2020; Wandel and Roos 2005). This is supported by the research conducted by Wandel and Roos (Wandel and Roos 2005) who showed that physical activity could represent an effective coping strategy, especially for high position workers. This is confirmed by the lower level of working mental effort found in the EG in the last days of the experimental period. Moreover, the trend evidenced by the SF-12 seems to follow the line drawn by the NASA-TLX's results; indeed, the MCS-12 showed a better improvement in the EG's mental condition, confirming the positive effect of the experimental procedure. The IPAQ did not show significant differences between the two groups in pre- and post-training conditions. The result seems to be contradictory with the higher number of minutes spent performing moderate physical activity recorded by the accelerometers in the EG. This lack of consistency between the accelerometers data and IPAQ data has been previously seen by Dyrstad et al. (Dyrstad et al. 2013). More specifically, Dyrstad highlighted that, in the IPAQ questionnaire, the participants reported less sedentary time, less moderate intensity and a higher level of vigorous intensity physical activity than what was measured by the accelerometers. Concerning the retention effect, despite an absence of significant intra-group differences in IPAQ, the results showed a difference in total Met values in favor of the control group, and the delta analysis seems to show that this difference could be due to a difference in walking activities (Chen et al. 2017). During the experimental interruption, the participants did not receive any indication about the behavior to maintain concerning physical fitness and this might have caused the difference in outdoor activities (Chen et al. 2017). It is necessary to mention that, in this period, the experimental group was not allowed to interact with any experimental procedure. Nevertheless, the employees of the EG were able to maintain the newly acquired levels of physical fitness during the retention test as evidenced in the previous paragraph.

4.3. Accelerometer

The analysis performed with the accelerometers underlines in EG a significant increase in minutes spent performing moderate physical activity and a decreasing trend of minutes spent in sedentary behavior. Even without significance, the EG evidenced a decrease of 5% of sedentary activities (from 84% to 79% of the total monitored time), while the CG did not show a similar trend (from 82% to 81%). Comparing the obtained data with the literature, it is possible to assess that the EG started with a mean time spent in sedentary behavior of 8.14 0.8 h/day, considered as a range of increase in mortality risk (from 7.5 to 9.0 h/day) by WHO guidelines (Bull et al. 2020), and finished the experimental procedure with 7.8 0.9 h/day, moving gradually away from the risk range.

4.4. TQR and Training Load

The lack of significances in TQR analysis seems to indicate that both of groups experienced similar recovery conditions, which corresponded to a "reasonable recovery". The same can be asserted for the training load, which presented the same trend for both groups for the entire experimental period. This last dataset appears to be at odds with the difference found in the effort values of the NASA-TLX, but it is necessary to specify that the NASA-TLX, as expressed by its protocol, is a self-reported questionnaire specifically that refers to the working task of the employee (Hart and Staveland 1988), and does not consider the physical fitness activity performed during working hours. Conversely, the training load was an evaluation of the general effort experienced during the working day which includes physical activity.

4.5. App UP150

The App UP150 permitted to collect data about the physical activity performed by the EG during the entire experimental period. In this way, it was possible to analyze and discuss the typology of fitness practiced, the reaching of the target score and the time spent conducting physical activity. The app showed that all participants were able to reach the target score set by the CFT. Moreover, it is important to underline that about 75% of the target score (144.2 ± 74.4 a.u. of 191.9 ± 29.7 a.u.) was reached in the workplace during working hours. This could represent an important goal in this new workplace concept; physical activity was able to efficiently fit in the workflow, reaching the important percentage of recommended weekly physical activity (Bull et al. 2020). The mean of the participants of the EG performed more than 350 min of physical activity during the week (summing the office physical activity and the outside office physical activity reported in the TD). Indeed, considering the accelerometer outcomes, it is possible to notice that the experimental group not only had an increased trend of moderate physical activity during the 8 weeks of intervention from 307.8 to 425.4 min (an increase of 3%), but even overpassed the minimum amounts of moderate minutes recommended of moderate physical activity. Nevertheless, it is possible to notice that the intensity of the activities perceived using the PT differs considerately from the intensity recorded by the accelerometers. The employees tended to underestimate the moderate physical activity, while tending to overestimate the light and vigorous physical activity. Moreover, the results show that the participants of the EG interpretated most of the moderate intensity as light intensity. This phenomenon could be due to an easier perception of personal lower and upper bounds of effort, caused by the more shared meaning of 'no effort' and 'maximal effort' (Marcora 2010) during physical activity, while the different variations in effort could be more difficult to perceive. Another factor that could have contributed to increasing the difference between perceived and measured intensity of physical exercise is motivation. Based on Brehm's motivational theory, if the task is perceived as adequate, the potential motivation that concerns the activity increases (Brehm 1989; Wright 2008). The increase in the employees' motivation can influence the perception of practiced physical activity (Brehm 1989; Wright 2008) and, as shown in the previous presented data, it is possible to notice that the minutes measured as moderate are more often perceived as light than vigorous.

4.6. Potential Limitations

The quarantine imposed to control the outbreak of SARS-CoV-2 could have influenced the participants' lifestyle and consequently some results. Therefore, it is necessary to investigate the efficacy of the UP150 during a normal period, outside the restrictions imposed by the pandemic. Moreover, the small sample size did not permit to compare the effect of the intervention on females and males separately.

4.7. Practical Applications and Future Perspective

Due to the modification of the classic workplace concept, even caused by the current pandemic crisis, the office needs to change old schemes, adapting to new working modalities that include both in-presence and smart working (Sica 2021). The office intended as a simple physical space of work must change to follow the employees' needs of organizational elasticity (both in-presence and smart working) and psycho-physical wellbeing (Sica 2021). From this new perspective, architectural changes could help the employees follow good practices for healthy behavior, facilitating the engagement with physical activity moments (Lindberg et al. 2018). Moreover, the inclusion of a new professional figure in the form of the wellness coach could represent not only a facilitator of physical activity, but even a favoring element of social relationships that could have a positive impact on the working environment (Beauchemin and Lee 2014). The technology must link the office (intended as physical space) with individual motivation (psychological level) and with opportunities of physical activities (fitness level) based on self-perception and regulation of effort. These three elements must be adaptable to the new working situation, switching from the in-presence to the smart-working modality and supporting the employees to develop healthy behaviors, even outside the working context. In future investigations, a larger sample size could help to strengthen the effects of the experimental protocol. Future research could focus the investigation on the longitudinal effects of the UP150 on the same proposed variables and could also prove the effectiveness of cardiorespiratory fitness and give better results in all other considered physical fitness categories (Dunn et al. 1999). Moreover, it could be useful to implement and verify the efficiency of new physical fitness stations linked to workflow moments or to active breaks, and the impact of the entire protocol on employees' illness and stress related absenteeism (Grimani et al. 2019).

5. Conclusions

The UP150 workplace intervention, based on architectural, technological, physical, and methodological components, seems to be efficient in the promotion of physical activity and an active lifestyle. In particular, the UP150 improved the employees' index of motor efficiency, increasing flexibility fitness and part of muscular fitness. Considering the proposed questionnaires, the intervention decreased the work-based mental demand, maintained a fair level of working stress-related effort, evaluated with the NASA-TLX, and improved mental health, evaluated with the SF-12. Furthermore, the experimental procedure increased the number of moderate minutes of physical activity practiced during the working week, reaching and overpassing the minutes recommended by the literature.

Appendix A

Table A1. Reliability results of the CFT.

	Session 1	Session 2	Session 3	ICC
Ruffier (AU)	14.4 ± 4.9	13.6 ± 5.1	12.6 ± 4.8	0.950
Chair sit and reach (Cm)	−3.4 ± 10.5	−3.2 ± 12.3	−0.9 ± 15.0	0.944
Shoulder mobility (Cm)	52.4 ± 9.8	51.2 ± 9.5	47.3 ± 8.6	0.965
Thirty second Seated Sit-Up (AU)	5.8 ± 3.3	7.3 ± 4.0	7.3 ± 3.7	0.804
Thirty second Push-up (AU)	3.1 ± 1.7	3.1 ± 1.5	3.9 ± 1.9	0.804
Index of Motor Efficiency (AU)	27.3 ± 12	30.7 ± 13.4	34.8 ± 14.1	0.957

Sessions 1, 2 and 3 represent the three sessions performed previously to the intervention. Data are shown as mean ± standard deviation.

Table A2. Results of the CFT's RPE analysis.

		Pre	Post	Retention
Ruffier (AU)	EG	5.3 ± 0.9	4.9 ± 1.2	4.9 ± 1.1
	CG	4.8 ± 0.7	4.8 ± 0.8	4.9 ± 0.9
Thirty second Seated Sit-Up (AU)	EG	4.2 ± 0.7	4.3 ± 0.6	4.1 ± 0.8
	CG	4.1 ± 0.6	4 ± 1	4.2 ± 0.7
Thirty second Push-up (AU)	EG	4.8 ± 0.6	4.8 ± 1.1	4.5 ± 0.8
	CG	4.7 ± 0.6	5.4 ± 0.9	4.8 ± 0.6

EG = experimental group; CG = control group. Data are shown as mean ± standard deviation.

Table A3. TQR and Training Load outcomes.

		CG	EG
		Mean ± SD	Mean ± SD
TQR	Pre	14.5 ± 1.7	13.8 ± 2.2
	Week 1	14.1 ± 1.4	13.7 ± 1.9
	Week 2	14.0 ± 1.6	14.2 ± 2.0
	Week 3	13.8 ± 2.0	14.7 ± 1.7
	Week 4	13.7 ± 1.4	13.8 ± 1.9
	Week 5	13.6 ± 1.7	14.2 ± 2.4
	Week 6	13.5 ± 2.2	14.2 ± 2.4
	Week 7	13.3 ± 1.7	14.2 ± 1.5
	Week 8	13.6 ± 1.5	14.1 ± 2.3
	Post	14.0 ± 2.3	13.5 ± 2.6
	Retention	14.7 ± 1.9	15.3 ± 2.7
Training Load	Week 1	2980.7 ± 793.5	3555.6 ± 1101.7
	Week 2	3210.2 ± 649.3	3313.9 ± 1184.3
	Week 3	2906.4 ± 838.1	3208.7 ± 815.8
	Week 4	3280.6 ± 660.2	3298.1 ± 1083.3
	Week 5	3189.4 ± 783.5	3284.2 ± 773.9
	Week 6	3155.3 ± 785.4	3469.3 ± 635.6
	Week 7	3002.3 ± 879.9	3316.7 ± 780.5
	Week 8	3337.4 ± 730.2	3375.1 ± 878.0

TQR values of pre, post and retention are referred to the measurements performed immediately before the CFT.

Design and construction B (*Step 5*)

Design and construction A (*Step 4*) gave quantitative information about the efficacy of the UP150 concept design. It was necessary to acquire qualitative information about workers' experiences during the experimental trial to ensure that the concept design could be efficient in promoting a healthy lifestyle and appropriately inserted into employees' working routines. Hence, *Step 5* aimed to investigate the workers' needs and workers' perception of physical activity at the workplace.

Enhancing motivation and psychological well-being in the workplace through conscious physical activity: suggestions from a qualitative study examining worker's experience.

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Abstract

Introduction: After COVID-19 restrictions, hybrid solutions were established that combined hybrid working and work in presence. Workplace conditions significantly impact employees' lives, particularly in terms of meeting their needs and promoting their wellbeing. Based on a socio-ecological and multilevel methodology, the UP150 concept (Proactive office 150) represents a possible innovative solution to meet employees' needs and valorize flexible work. It encourages physical exercise and active breaks during the typical workday by using particular architectural modifications, a dedicated App, and physical activity professionals as wellness coaches. The present study is the last step of the preliminary actions planned to check the benefits of the UP150 concept and aims to explore the workers' perceptions after experiencing this project.
Methods: The qualitative analysis of a preliminary survey (concerning information about the company structure and workers' habits) performed before conducting a randomized controlled trial intervention study and the analysis of the semi-structured interviews after 8 weeks of a UP150 experience served as datasets for this study and have been examined and discussed.
Results: In the preliminary survey, the young (under 40) and generally active (57% of the workers) reported being motivated to exercise but inhibited by a lack of time and a heavy workload. After 8 weeks at a modified workplace designed in accordance with the motive behind the UP150, the workers displayed noticeable positive perceptions and appreciation.
Discussion: The qualitative analysis confirmed and supported the effectiveness of the UP150 concept that previous research had already found in quantitative parameters related to employees' motor efficiency, psychophysical status, and amount of physical activity. Participants reported beneficial perceived effects on their wellness and psychophysical status following a UP150 experience. Moreover, the concept improved social relationships and increased motivation. In conclusion, the UP150 concept e_ciently fostered a positive perception of physical exercise and directed the employees toward the assumption of healthy behaviors fitting the physical literacy paradigm.

Keywords: transdisciplinary, physical literacy, ecologic approach, self-monitoring, welfare

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1. Introduction

The COVID-19 pandemic has dramatically altered our society and human behavior. For example, the restrictions led to a change in working habits, and innovative solutions, such as hybrid working, have been promoted or encouraged. The working environment is of utmost importance for people's productivity and, above all, their wellbeing. Indeed, action plans such as the Luxembourg Declaration on Workplace Health Promotion in the European Union (ENWHP 2018) or the documents from the Italian National Institute for Public Policies' Analysis (INAPP 2017) consider the workplace to be a fundamentally important place where people's ecologic and healthy behaviors can be altered. The literature evinced that smart working increased the workers' sense of autonomy and independence. Research by the Nomisma observatory reported that 56% of the Italian workers interviewed would like to keep working part-time smart work after the lockdown (Nomisma 2020). However, even before the pandemic that negatively affected the working social context (Risi and Pronzato 2021), an ideal office configuration was already demonstrated to positively influence autonomy, relationships between colleagues, participation in working life, and, more generally, workers' wellbeing perception (McGuire and McLaren 2009). Furthermore, how the worker lives in the workspace is essential as well. Research on activity-based workplaces shows how getting up from the workstation and being active is beneficial. Movement-based breaks increase the workers' perception of their wellbeing as long as they do not significantly cut into productive work time (Haapakangas et al. 2018). Exercise during the usual daily workflow makes the worksite more proactive, which enhances workers' self-awareness and physical efficiency (Jindo et al. 2019; Tsai and Wang 2016). Again, the companies benefit more from promoting employees' physical activity: productivity, work performance, and workers' mood all improve (Grimani et al. 2019), and medical costs and costs from absenteeism become considerably lower (Baicker et al. 2010). Many organizations considered hybrid working solutions, combining smart working and working in presence during the week to meet the employees' needs (Langè and Gastaldi 2020). This solution positively affects productivity, mental health, and work-life balance due to better management of employees' working and free time (Angelici and Profeta 2020). Particular attention must be paid to the worksite where the employees return to work on alternating smart-working days. The UP150 concept (Invernizzi et al. 2022) offers a possible way to meet employees' needs and valorize flexible work. UP150 stands for "proactive office," in which 150 weekly minutes of moderate physical activity are promoted according to the World Health Organization's suggestions to preserve individual health. Specifically, the concept supports "a non-traumatic transition from the classic workplace concept (based on constriction, stress, and health risks due to a sedentary lifestyle) to a new workplace environment and office's design concept (considering the well-being and the caring of employees as central elements of companies' welfare strategies)." The UP150 concept can be defined as a theory-based intervention aiming to develop healthy habits and lifestyles from physical literacy's theoretical assumptions, contextualized and integrated into the workplace. Physical literacy (Whitehead 2013) starts with developing skills, knowledge, and understanding of the practiced activities, motivating physical activity, and trusting in proposals so individuals can pursue and consolidate active lifestyles and habits to preserve good psychophysical health and prevent illness. However, this assumption cannot and should not be limited exclusively to the goal of making workers healthy to preventing illnesses. Indeed, physical literacy involves a holistic, multidimensional, and broader vision of physical education that acknowledges physical exercise as having a positive impact on all dimensions (cognitive, social, affective, and motivational) of an individual (Edwards et al. 2017). Hence, to have long-term effects, the education of the movement that begins in infancy should immediately embrace the dimensions mentioned above, be continued along all evolutive stages, be retained in adulthood, and be continued until old age (Carl et al. 2022; Rudd et al. 2020). In this monistic vision, the cognitive, psychological, social, and linked-to-movement areas are not disconnected but mutually influence each other. Indeed, moods and positive experiences combined with adequate information stimulating awareness are powerful in learning and maintaining physical abilities. Moreover, they can be more easily adapted and reused in different contexts, encompassing numerous dimensions of everyday life (Cairney et al. 2019). Since physical literacy is a holistic theory embracing multiple areas of human experience, interventions based on the previously mentioned principles need to operate in several areas to create psychophysical wellbeing by favoring “enriched” environments from both a social and structural point of view through targeted projects and adequate methodologies (Bauman et al. 2012; Lakerveld et al. 2012). With this in mind, an increasing number of studies suggest interdisciplinary “multilevel” projects based on socioecological models that consider the relationship between factors that, in a given context, may affect an individual’s general wellbeing more or less directly (McLeroy et al. 1988). In particular, when considering creating a favorable environment to promote psychophysical wellbeing education through motor activity, a multilevel model with different action levels should be considered, which addresses the following: (a) public policies, i.e., scientific evidence-based guidelines to disseminate in public and private institutions involved in planning and managing specific actions tailored on specific characteristics of the recipients (children, adolescents, adults, and the elderly); (b) school, corporate, and welfare-type community classifications, which should be encouraged to promote information regarding good wellbeing practices; (c) organizations involving experts prepared for designing specific interventions based on the context and recipient requirements; (d) interpersonal relationships promoting social health by increasing inclusion and productivity; (e) individual needs, i.e., focused on mental and physical health by promoting self-esteem, reducing the risks of anxiety and depression and addressing overweight and metabolic issues, respectively (Bull et al. 2020; Invernizzi et al. 2022; McLeroy et al. 1988). The “socio-ecological filter” can also refer to the environment. It represents an essential element through which individuals can interact with a specific space that can limit (constraints) or favor (affordances) behaviors. Constraints and affordances can favor personal adaptations that benefit good wellness practices. They grant a certain degree of autonomy whenever physical exercises are directly selected and tailored according to the individual psychophysical characteristics and conditions (Bauman et al. 2012; Rudd et al. 2020). In this case, the multifunctionality and the design devoted to “spatial manipulation” are fundamental to allowing individuals to explore, discover, adapt, and self-organize their psychophysical behaviors by choosing the best response to deal with the specific individual, environmental, and task constraints affecting the different contextual situations. UP150 principles, based on a socio-ecological and multilevel model, followed the self-determination theory’s key points, including promoting autonomy, competence, and relatedness (Invernizzi et al. 2022). In this regard, the principles of self-determination theory have been widely applied in workplace design and have proven to be effective in improving employees’ well-being, increasing motivation toward work and work performance (Deci et al. 2017; Olafsen et al. 2017; Rigby and Ryan 2018). Specifically, the principles are applied via three main actions: architectural changes, a dedicated mobile app, and the intervention of wellness coaches (Invernizzi et al. 2022). The present qualitative research completes a previous analysis of the effectiveness of applying the UP150 principles by Invernizzi et al. (Invernizzi et al. 2022). The present study aimed to investigate, through semi-structured interviews, the employees’ perceptions of implementing physical activity during their working routine in a UP150 setting. Data were surveyed before, and interviews were proposed after the randomized controlled trial study by Invernizzi et al. (Invernizzi et al. 2022). We expect to understand which factors, among architectural changes, wellness coaches, and dedicated apps, impacted workers who alternated working at the UP150 office with smart working. We hypothesize that employees’ mental and physical health improved and that these changes, whether validated by workers’ perceptions or not, are the consequence of an equal contribution from the three factors. This study explored the participants’ representation of outcomes and benefits of UP150 experimentation by adding physical practice during working activity. It represents an essential asset from which a multilevel approach can be developed and maintained to promote wellness and health at work. Furthermore, the results of this study and policies that encourage cooperation between universities and factories can lead to interventions that help workers' health throughout their lives based on their needs.

2. Methods

2.1. Study design

The present study completes the UP150 intervention that promoted employees' wellbeing by modeling the workplace environment to include active breaks and physical exercise during the usual daily workflow (Invernizzi et al. 2022). Figure 1 shows the timeline of the UP150 concept. The subsequent sections provide the details of each step (#1 to 5), allowing the reader to better understand the concept and its motive. Specifically, the present study analyzed the data collected before and after the experimental study of the UP150 concept (steps #2 and #4, respectively) and discussed the effects of the worker's perception of the experimental period (step #5).

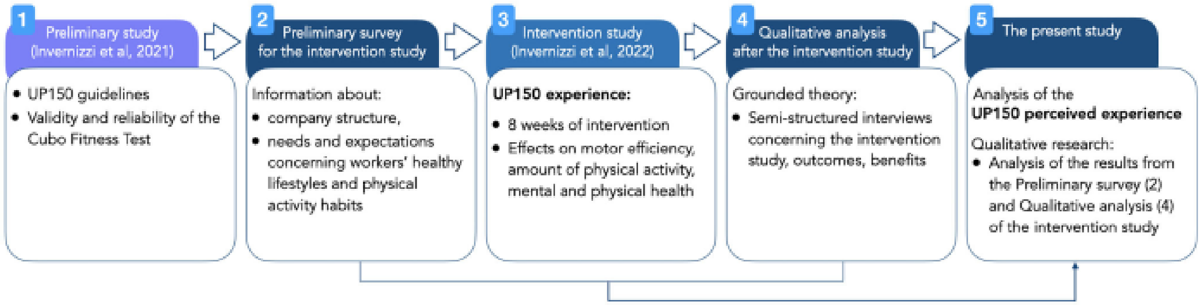

FIGURE 1
Timeline of phases and rationale of the UP150 concept and the present study's design (interventions, surveys, and analyses).

2.2. Preliminary study

As a first step (Figure 1, step #1), a preliminary study (Invernizzi et al. 2021) was conducted on 54 individuals (21 women and 33 men, aged 20.0 ± 4.2 years). The study assessed the validity and reliability of the Cubo Fitness Test (CFT), the diagnostic tool designed to screen the physical efficiency of participants in the upcoming UP150 intervention research.

This phase represented the organizational setup of the concept, based on a four-step roadmap to integrate physical activity into the usual workflow: evaluating, widening, organizing, and disseminating. CFT evaluates motor efficiency (cardio-respiratory and muscular endurance, flexibility, core muscular efficiency, shoulder mobility, and upper body strength) through submaximal exercises. They contemplate skills involved in injury prevention (upper body strength to mitigate a fall) and promotion of lifespan functional autonomy (raising the body from a sitting/lying position to a standing one; raising the arms to reach an object placed overhead; putting on a jacket; easily brushing the back with a sponge, or flexing forward enough to put on the socks). The submaximal tests are proposed at a moderate intensity of the perceived exertion scale, and their good validity scores and reliability have already been demonstrated (Crotti et al. 2018; Invernizzi et al. 2020, 2021, 2022). Widening is intended to offer occasions to increase the employees' exercising during or outside of their daily working time thanks to new tools such as the UP150 App, which assists and encourages exercise and helps them arrive at a target score calculated by the app based on the quantity of movement performed weekly. Because of the CFT, the physical efficiency level can be easily established and checked. It indicates the expected weekly score to set in the UP150 App and the recommended exercise type. Organizing refers to managing the amount and type of physical activity to suggest to the employees based on the context and type of their job. For this purpose, professional wellness coaches guarantee the process supervision and promote the dissemination and activation of the whole concept. activity.

2.3. _Preliminary survey

The survey was composed of a descriptive section in which employees were asked to report their age range, gender, and occupation and an explorative section consisting of three multiple-choice questions regarding (a) the workers' habits concerning nutrition and physical activity (one selection admitted); (b) the workers' principal motivation in engaging in physical activity (one selection admitted); and (c) possible obstacles to engaging in physical activities (multiple selections admitted). The preliminary survey's outcomes are presented in this paper's results section.

2.4. Intervention study

The intervention study (Figure 1, step #3) evaluated the effectiveness of the UP150 concept in increasing the participants' motor efficiency, improving psychophysical status, and increasing the amount of physical activity performed (Invernizzi et al. 2022) using the CFT, NASA-TLX, and SF-12 assessment tools, respectively and accelerometers. It involved participants from the same big software company in which the preliminary survey was accomplished. Forty-five volunteers were randomly assigned to an experimental group (EG, n = 23) and a control group (CG, n = 22). Five participants withdrew during experimentation and were, therefore, excluded from the study. Analyses were performed on participants who completed the protocol (EG, n = 20, 60% women, age 31.7 ± 8.2 years; CG, n = 20, 60% women, age 32.0 ± 4.4 years). EG worked for 8 weeks in the new worksite environment as designed according to the UP150 concept, alternating 3 days on-site in the office with 2 days at home in smart working. The UP150 office had been equipped with stations for active pausing or exercising during the usual workflow, which permitted strict interaction with the UP150 App by pairing fitness equipment with working and personal devices (Figure 2).

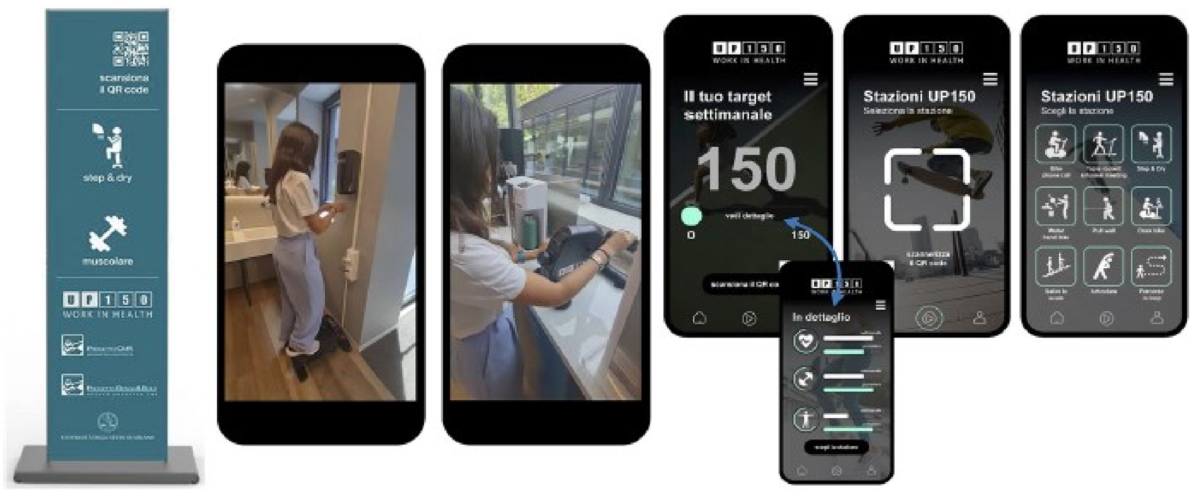

FIGURE 2
Example of architectural changes and setting for the UP150 office concept, and interaction with the UP150 App.

Employees could access them at any time. Stations were placed to increase displacements, making different environments for short regenerating breaks without representing a source of disturbance for other employers at work. In addition, EG participants used the UP150 App to interact with architectural changes in the experimental worksite setting and to trace any physical activity performed during or outside working hours. Finally, EG participants benefited from a wellness coach who followed their physical activity and was available two times a week at the office or daily by remote video calling. In contrast, CG continued its usual working and living habits, alternating standard office work (3 days per week) with smart work (2 days per week).

In detail, architectural changes were changes that influenced the working environment. For several decades, architects have sought to integrate the fields of neurology, psychosociology, and neurophysiology into their practice. A new awareness based on scientific evidence is thus being defined for environments that have been built: they impact perceptions and, as a consequence, processes of the nervous systems, interfering with our emotions, cognitive abilities, and interactions to the point that they affect even more complex behaviors and shape our lives and actions (Higuera-Trujillo, Llinares, and Macagno 2021). The architectural changes involved not only the design of the building but even the inclusion of some physical activity stations (a treadmill in the break room, rubber bands, wooden sticks, and steppers) and the implementation of workflow physical activities (cycling or walking during online or presence meetings or the prevalent use of stairs for moving to another floor), which allowed people to interact with and live in the working space actively and innovatively. These changes required interventions on 10% of finishes (floating floors, suspended ceilings, and cladding walls), 30% of furnishings (chairs, desks), 50% of water, food, and air to dry hands, and 30% of modifications to the mechanical, electrical, and hydraulic systems. The architectural changes were also related to the use of technology to encourage autonomous and conscious approaches to physical activity within a particular context, such as the workplace. These innovative environmental changes enabled the employee to choose what exercise to do and how much time to devote to it, favoring the use of a dedicated app over mobile devices. Indeed, all the involved employees were equipped with the UP150 App that provided a weekly activity score (a target score to reach) calculated by a system point based on activity duration and individual perceived effort (Invernizzi et al. 2021, 2022). In addition, the app also records physical activity performed during the extra-working time or the smart-working condition. Finally, in the UP150 socio-ecological model, professional figures graduates in sports science and named wellness coaches further promoted physical activity in both presence and remote working modalities. The wellness coaches taught the employees how to practice physical fitness responsibly by self-monitoring based on the rate of perceived exertion. With their degrees, the employees were helped to reach the targeted weekly amount of physical activity and guided to correctly choose, dose, and execute the exercises during this novel experience. Self-monitoring is essential to adapt behaviors and reach psychophysical wellbeing, considering the typical socioenvironmental and interpersonal situations emerging from the specific working context (presence or smart working). Assessment tools for one's psychophysical efficiency based on the perception of effort (such as the CFT by Invernizzi et al. 2021) and the employees' daily activity and physical condition self-assessment through the UP150 App (pocket trainer) allowed for self-monitoring (Suchert et al., 2013; Invernizzi et al. 2022), and aimed to boost an ever-greater competence in holding the appropriate approach to physical exercise within a work context. The employees' ability to regulate and dose physical behaviors to accommodate social work situations was promoted by a clear policy supervised by a joint academic and company and by encouraging interaction with wellness coaches that favored relationships and confrontation between employees during active breaks or breaks in dedicated spaces arranged explicitly for this purpose. The wellness coaches had to create a pleasing working environment whenever physical activity during working time was perceived as an embarrassing moment and a waste of time instead of a well-accepted opportunity for discussion among colleagues. Altogether, these factors allowed one to choose with competence and awareness the type, place, duration, and intensity of the physical activity necessary to reach optimal psychophysical wellbeing without compromising on the assigned work. Specifically, the results of the UP150 study demonstrated an increase in physical fitness, an improvement in mental health, and a better ability to cope with the workload, highlighting the effectiveness of this multilevel approach based on promoting physical activity in supporting employees during their daily working lives. Indeed, the motor efficiency and moderate physical activity of EG improved compared to CG. At the same time, during working activity, mental demand diminished and mental health (as measured by MCS12) increased, confirming the efficacy of the UP150 concept in acting as a proactive environment to improve the employees' physical activity, mental health, and wellness. A synthesis of the outcomes of the intervention study related to the participant's motor efficiency, psychophysical status, and increase in the amount of physical activity (Tables 1, 2).

Table 1. Main outcomes of the intervention study (Invernizzi et al. 2022).

Domain	Tool	Variable	Group	Pre	Post
Motor efficiency	CFT	Index of motor efficiency (AU)	EG	29.4 ± 13.7	$43.0 \pm 2.3^{\#}$
			CG	32.2 ± 11.7	36.0 ± 2.6
Occupational workload	NASA-TLX	Mental demand	EG	50.3 ± 28.5	$13.0 \pm 24.9^{\#*}$
			CG	40.3 ± 30.7	24.6 ± 27.0
		Effort	EG	27.2 ± 15.7	$37.3 \pm 24.4^{*}$
			CG	20.6 ± 17.1	$60.6 \pm 24.6^{\#}$
Psycho-physical health	SF-12	MCS12	EG	37.5 ± 9.8	$46.6 \pm 8.2^{\#}$
			CG	39.2 ± 9.0	$42.3 \pm 12.2^{\#}$

CFT, Cubo Fitness Test; MCS12, Mental Component Summary; EG, experimental group; CG, control group; Data (scores) are shown as mean ± standard deviation. *Different than CG in the between-group analysis ($p < 0.05$); #Different than Pre in the within-group analysis ($p < 0.05$).

Table 2. Main outcomes of the intervention study (Invernizzi et al. 2022) related to the amount of physical activity measured by accelerometers at four time points (detections 1–4).

Intensity of the physical activity	Detections	CG (min per week)	EG (min per week)
Moderate	Detection 1	300.9 ± 139.0	307.8 ± 176.7
Moderate	Detection 2	281.7 ± 171.6	$355.4 \pm 124.8^{\#*}$
Moderate	Detection 3	345.9 ± 200.6	$392.9 \pm 153.7^{\#§}$
Moderate	Detection 4	314.7 ± 117.3	$425.4 \pm 175.9^{\#§}$

Detections were performed every 2 weeks. CG, Control Group; EG, Experimental Group. Data are shown as mean ± standard deviation. *Different than CG in the between-groups analysis ($p < 0.05$); #Different than detection 1 in the within-group analysis ($p < 0.05$); §Different than detection 2 in the within-group analysis ($p < 0.05$).

2.5. Qualitative analysis after the intervention study

After 8 weeks of intervention, 20 participants (12 women and eight men, ages 31.78.2 years) in the intervention group of the study by Invernizzi et al. (Invernizzi et al. 2022) were interviewed (Figure 1, step #4) and composed the sample for the qualitative analysis. Specifically, the semi-structured interviews asked the following questions: (i) What differences do you perceive in your health status at the end of the UP150 intervention?; (ii) Which factor among architectural changes, wellness coaches, and the training (the Cubo Fitness Test, App UP150) influenced you most? Which of these do you consider irrelevant? Is it possible to improve some of them?; (iii) How did you experience the integration of physical activity in the standard workflow? Underline the positive and negative aspects you perceived; and (iv) Did you perceive any change in relationships between colleagues and bosses within the working context? The answers were grouped to evaluate their respective frequencies. The semi-structured interviews were recorded and analyzed using the grounded theory method (Corbin and Strauss, 1990) using line-by-line coding. In the first step of open coding, themes defined as pre-labels were extrapolated. Next, pre-labels expressing similar concepts were grouped into labels. After that, subsequent axial coding was completed to group labels into categories that were quantified according to how often they appeared in the interviews. Labels with a frequency lower than 50% were defined as "sporadic," in the 51–70% range as "typical," and higher than 71% as "general." The category presenting the highest percentage frequency was identified as the core category. This coding process was performed by two evaluators with an inter-rater consensus and successively discussed with the research team. The analysis of labels and categories was accomplished by the MAXQDA software (VERBI GmbH, 2022). The outcomes of the analysis of the interviews through grounded analysis are presented in the results.

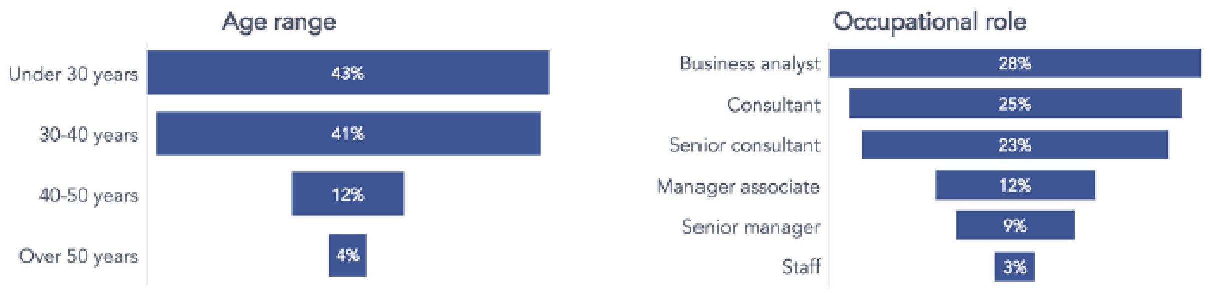

FIGURE 3
Participants' demographics concerning age and occupational role in the preliminary survey before the UP150 intervention study.

2.6. Analysis of the employees' perceptions of the UP150 experience

As previously mentioned, the present study (Figure 1, step #5) ended the actions planned to assess the benefits of the UP150 concept and examined the workers' perceptions of it. The qualitative analysis of the preliminary survey (step #2, on information about the company structure and workers' habits) and semi-structured interviews after the intervention study (step #4) served as datasets to be examined and discussed. The present study was conducted following the Declaration of Helsinki and was approved by the Ethics Committee of the University of Milan (14 September 2020, Number 84/20).

3. Results

3.1. Outcomes of the preliminary survey before the intervention study

The preliminary survey results accomplished before the UP150 intervention study depicted detailed information about the software company's employees and their habits related to healthy lifestyles. Figure 3 reports the participants' demographics by four age-range classes (under 30 years, 30–40 years, 40–50 years, and over 50 years) and their occupational roles, displaying the business setting of the company. The mean age of the employees was very low (most of them were under 30), and they predominantly worked as business analysts (28%), consultants (25%), or senior consultants (23%). Three questions have been posed in the survey. The first question ("Which definition better describes how you take care of yourself?") specifically investigated beliefs about nutrition and physical activity habits. As a result, most of the employees (57%) considered themselves physically active and cared about the nutritional aspects of their food. In comparison, a considerable part of the remaining respondents (39%) answered that they would like to be more active and attentive to nutrition. Still, they lack the discipline to successfully adopt and keep such a good habit (Figure 4). A second question was posed to gather information about the reasons and motivations inducing respondents to engage in physical activity. Many of them (Figure 5) reported practicing physical activity to improve or maintain physical fitness (40%) and health (26%). Finally, a third question identified which exercise barriers the respondents perceived as limiting their practice. Respondents could select more than one answer. Most of them considered lack of time (33%), tiredness from daily work (heavy workload, 21%), lack of consistency (14%), and laziness (11%) as the main barriers to exercising (Figure 6).

3.2. Outcomes of the qualitative analysis after the intervention study (analysis of the employees' perceptions of the UP150 experience)

The qualitative analysis of the semi-structured interviews conducted using the grounded theory approach allowed us to define the most recurrent subjects (categories and labels) and the connections

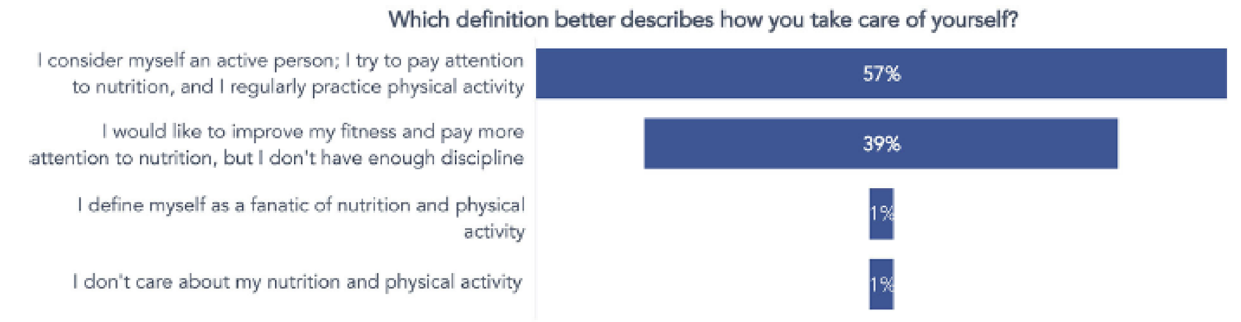

FIGURE 4
Answers to the question concerning the beliefs about personal attention to nutrition and practicing physical activity.

among them (Figure 7). A core category highlighting a generally positive perception of the UP150 intervention emerged. This positive perception is associated with general wellbeing and psychophysical state improvements, as denoted by the following comments: "I feel better while working in a UP150 context, days are lighter," and "I perceived physical and mood improvements." In addition, while direct feedback on the overall UP150 experience was the only topic of the first question, the participants also indirectly demonstrated their satisfaction by highlighting many additional positive features in answering the other questions, which appreciation can be adduced to a junction of several further aspects.

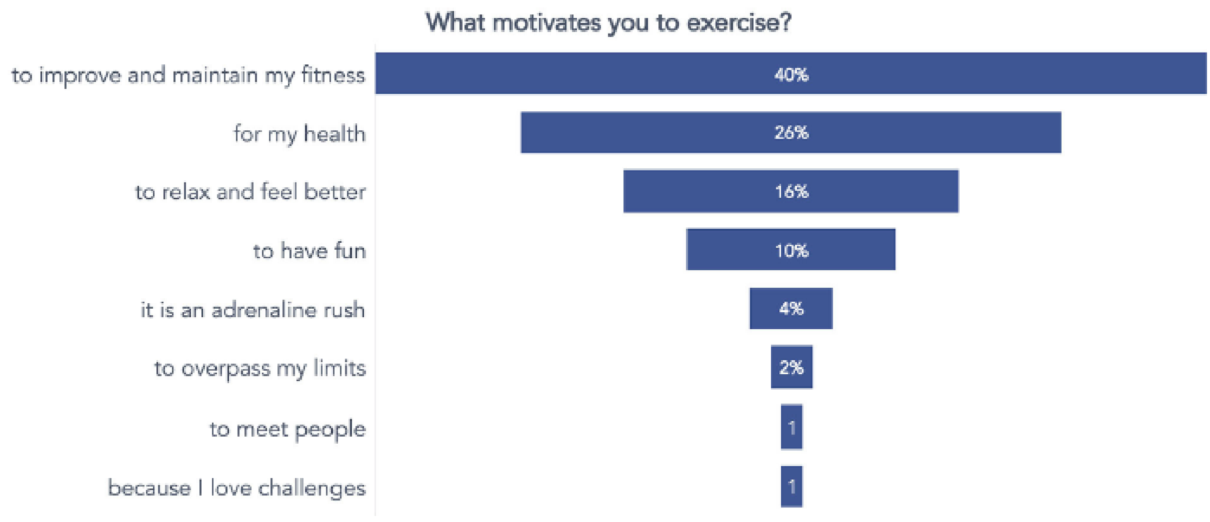

FIGURE 5
Answers to the question concerning the beliefs about motivations toward practicing physical activity.

One of them was motivation: participants reported that the intervention considerably increased their enthusiasm toward physical exercise ("The concept encourages me to move more"), which positively affected psychophysical wellness. In addition, the employees reported a significant change in their daily working routine in favor of a healthy-oriented lifestyle thanks to the improved predisposition to move ("I got new and more healthy habits"). Moreover, the element most likely affecting motivation appeared to be the presence of the wellness coach at the workplace ("The presence of the health coach served to motivate me with constancy"). Instead of having the wellness coaches available daily by remote video calling and just two times a week at the office, the employees would have appreciated an ulterior, more frequent attendance of them at the worksite and during worktime ("I would have desired the wellness coaches to be more frequently available at work and during worktime"). The UP150 App and the architectural changes of the workplace were also suggested to have effects on motivation to exercise. Indeed, the App made the employees feel motivated to reach the targets, both at work and outside of work time ("The App helped me be persistent in exercising through the calculation of the target score I had to reach"). They also traced the individual physical activity performed and easily monitored the personal improvements over time ("Thanks to the real-time update of the score, I was more conscious about the physical activity I did"). Furthermore, the app, connected to the workplace setting, promoted frequent active breaks during the workflow, improving the workers' motivation and psychophysical wellness ("I appreciated active breaks as they rested me from working"). Similarly, the workplace setting has been valued by the employees, who reported they appreciated the equipment disposition and the worksite design. Regarding socio-relational aspects, several participants conveyed that those architectural solutions improved interpersonal relationships within the business context ("The climate at work improved: practicing physical exercise with colleagues enhanced relationships"). Specifically, having joint active breaks or exercising helped to create more interactions and, consequently, improve communication and working relationships among colleagues ("The workplace was comfortable, and exercising with colleagues improved relationships").

4. Discussion

This study investigated qualitative changes in perceptions of wellness and physical engagement among employees who benefited from 8 weeks of an intervention enhancing active breaks during the working routine and daily physical exercise through architectural changes to the workplace, exercising reinforcement via a smartphone app, and wellness coach support. The participants, whose increased motor efficiency and mental health were retrieved in previous quantitative analyses of the intervention outcomes, benefited from the intervention and improved their perceptions of wellness and psychophysical status. From the preliminary survey, some issues emerged and were considered to guide the upcoming intervention. For example, the prevalently young (under 40) and generally active (57%) workers reported being motivated to exercise but needed more time to do it. They were often discouraged from practicing because of the tiered workload. It is a common problem in desk workers (Burton and Turrell 2000; Desmond et al. 1993), which drives the promotion of physical exercise in the workplace, as the UP150 concept pursues. Encouraging physical exercise in the

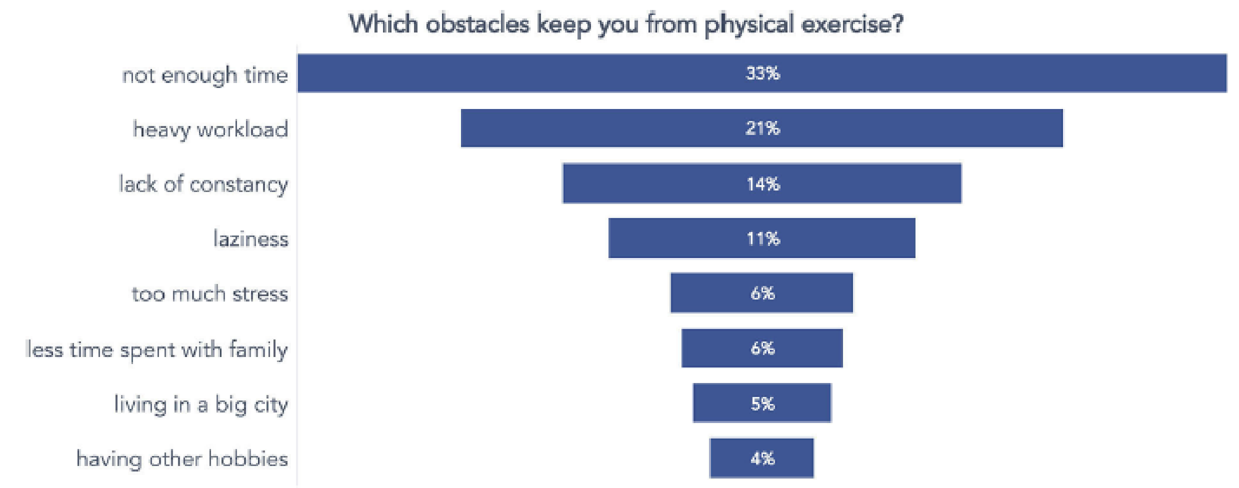

FIGURE 6
Answers to the question concerning what respondents consider a barrier to exercising.

workplace is a practical and effective solution to combat the widespread problem of sedentary behavior and accommodate the many employees who want to maintain or begin an active lifestyle but face barriers to doing so. The workers exhibited noticeable positive attitudes and appreciated the 8 weeks in a modified workplace developed in accordance with the UP150 concept and supported by a smartphone App and wellness coaches. Specifically, from the analysis of the grounded theory model based on responses given to the semi-structured interviews, 89% of the participants in the intervention study experienced improvements in physical and mental wellbeing associated with an increase in weekly physical activity. Consistent with the intervention's multifactorial nature and relying on the principles of self-determination theory, the UP 150 concept managed components (wellness coaches, apps, and architectural modifications) to improve physical activity and engagement. As the socio-ecological model expresses, individual behaviors can modify when environmental interventions embrace different areas of social influence (McLeroy et al. 1988). In agreement with the study by Faigenbaum et al. (Faigenbaum, Rebullido, and Chulvi-Medrano 2020), also in the present study, the facilitators (in our case, the wellness coaches) and facilities (in our case, the architectural changes and the App) met the employees' baseline needs to overcome the barriers to exercise (workload and lack of time) that they highlighted in the preliminary survey. Figure 8 shows the UP150 concept approach and represents connections among the rationale's components, from planning to applications. The workers' perceptions are consistent with the employees' motor efficiency, psychophysical status, and physical activity in the randomized controlled trial intervention study (Invernizzi et al. 2022). The participants improved their weekly moderate physical activity and reduced sedentary behavior, which agrees with the physical literacy concept. They urge individuals to appreciate and engage in lifelong physical activity by promoting motivation to move and mindful behaviors to reach and preserve psychophysical wellness (Carl et al. 2022). According to Rigby and Ryan (Rigby and Ryan 2018), the autonomy, competence, and relationship applications, which are distinctive of the self-determination theory on which UP150 stands, are the key issues enhancing motivation originating from the modified worksite that the current project provided. In this way, despite mainly being previously seen only as an impediment to healthy motor habits, the office has become a motivating and compelling part of the workers' physical activity. The self-monitoring UP150 App further contributed to promoting physical exercise. The UP150 App merges the concepts of autonomy and competence. Due to its interactive training diary, it allowed the employees to track any performed activity and self-monitor the achievement of the weekly engagement target. Undoubtedly, the employees appreciated this support for supervising the road-to-target: "Having a target to achieve helped me find times of day to move," they said. Nevertheless, such a positive tendency is frequent. It has already been studied in the literature that demonstrates the effectiveness of the hand-held devices available on the market in promoting physical exercise (King et al. 2008).

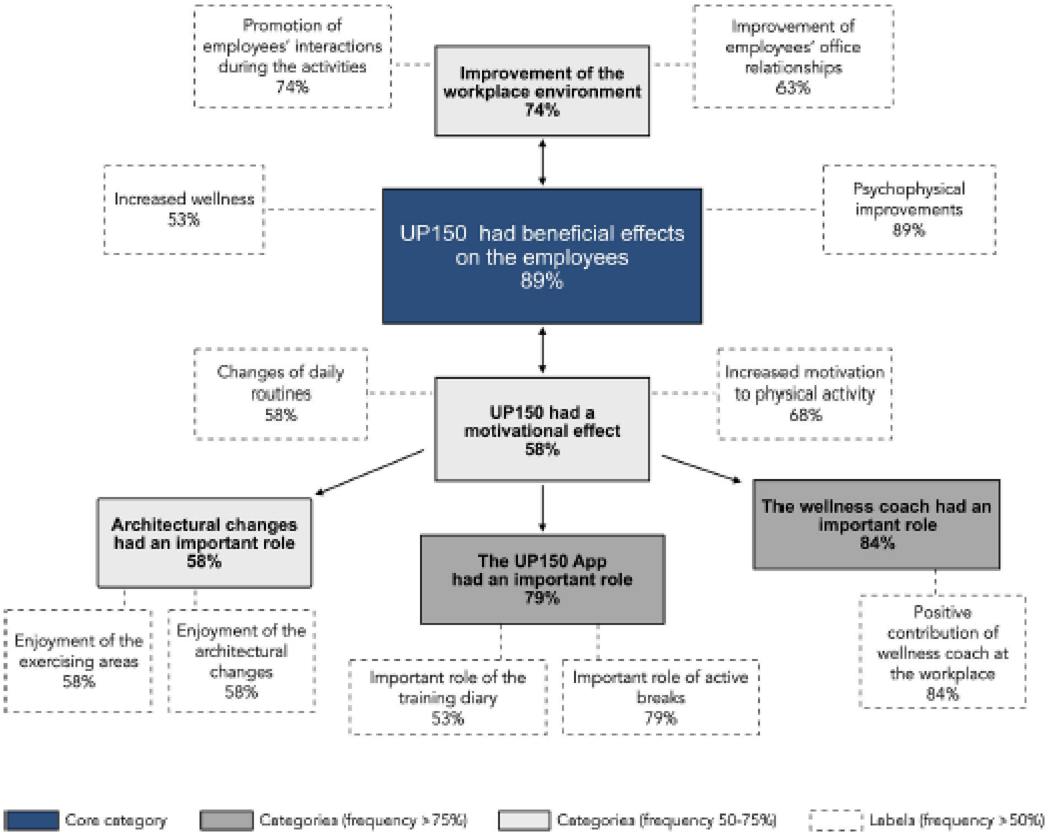

FIGURE 7
Subjects emerging from the semi-structured interview that were administered after the UP150 intervention and analyzed by the grounded theory method. The figure reports: in **blue**, the core category; in **dark gray**, the most recurrent categories (frequency of pertinent labels >75%); in **light gray**, categories having a pertinent labels occurrence between 50 and 75%; in **white**, the most recurrent labels for each respective category (which have been mentioned by at least 50% of participants).

Also, this innovative self-monitoring system has been designed based on perceived exertion, allowing participants to practice individually and autonomously in working and nonworking contexts. Since this underpinned self-determination principles (Deci et al. 2017), it could have fostered positive experiences and perceptions about wellness and workplace improvements, enhancing the employees' appreciation for the app. Architectural changes, such as creating dedicated areas to favor movement and social interactions, also positively affected the company's workplace environment. The literature documents how motivational effects from workplace architecture changes can enhance job satisfaction, provided they are well contextualized and shared with the employees (Bjerke, Ind, and de Paoli 2007). In our specific case, exercising was included in the usual workflow. The percentage of workers reporting motivational effects from the UP150 concept (58%) seems to support the idea that architectural changes have been adequately contextualized in the workflow and positively shared by workers. The appreciation of these new working areas was undoubtedly favored by wellness coaches' intervention, which is pivotal to generating competencies and promoting relationships. Indeed, the interviewees reported that their activity at the worksite had a very positive impact ("the coaches suggested several exercises; I did not perceive shame in performing, even if I was at work"). Nevertheless, coaches did not limit themselves to supporting the employees in exercising and adapting practices to individual needs; they had the function of sustaining employees in the transition from the standard workplace conception to a new thought about practicing physical activity in a formal environment, such as the workplace. In addition, the wellness coaches had a meaningful educational role: they guided the employees in managing the active breaks by autonomously handling exercise and training loads based on perceived exertion, thereby acquiring competence in self-monitoring (Butterworth et al. 2006; Suchert et al. 2013). Notably, active breaks during the usual workflow have been appreciated by 79% of participants. The introduction of such a strategy was fundamental for enhancing the employees' motivation to exercise and helped the wellness coaches guide employees' attention and techniques for managing workloads. Underneath such strategies, active breaks (and ways to address them) enabled autonomy, competence, and relationships. They appropriately responded to one of the occurrences that emerged from the preliminary survey (Figure 6), impeding or limiting the practice of physical activity: a lack of time and "work pressures," often causing anxiety and extra-working engagements. As previous research already highlighted (Invernizzi et al. 2022), the active breaks strategy allowed workers to find time to exercise at work and offered an approach to dealing with working loads and mental stress (Teixeira et al. 2012).

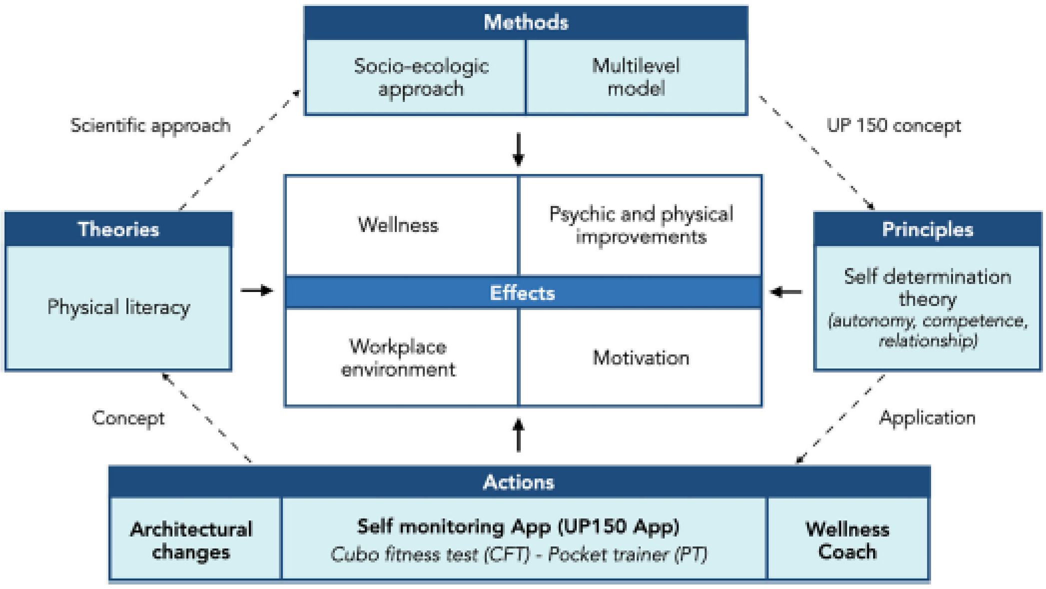

FIGURE 8
The rationale of the UP150 concept.

Including exercises in the workflow exploited the workers' routines: "I have found a place for new routines throughout my working day." Further habits and adaptations to the modified environment originated from the new workplace concept (and, therefore, from the alternative idea of workflow). These healthy habits fit the reference theory on which this study is based, i.e., physical literacy. Hence, the UP150 concept created a framework also permitting the workplace to become an educational place, promoting healthy habits that workers can preserve until they are elderly, and allowing workers to manage their working time and workloads adequately. The socio-ecologic approach positively affected the intrapersonal sphere: participants reported improvements in the company's social climate. These improvements have been attributed to the active-break strategy and the advancement of active relationship occasions. Indeed, in the socio-ecologic model, the social environment is decisive in advancing physical exercise: watching other people being active or practicing physical activity at an organizational level is one of the factors contributing to physical exercise promotion (Bauman et al. 2012). In the UP150 concept, active breaks and interactions were intended to make the employees interact during the workday and enhance interpersonal relationships. Positive benefits from the company's workplace environment are not unexpected: wellness at work highly depends on the working environment, which further relies on workers' interpersonal relationships (Desrumaux et al. 2015). The UP150 concept, in particular, promoted a positive company culture by encouraging employees to interact with one another through the use of active breaks within a socio-ecologic multilevel-model framework, which in turn influenced the employees' perception of the intervention's positive effects on their health (Invernizzi et al. 2022). The improved mental health of the experimental group (workers in the UP150 office) in comparison to the control group (employees in a conventional workplace) confirmed the coping impact of physical exercise in high position employees (Faulkner et al. 2020; Wandel and Roos 2005). The company's peculiarities and the limited duration of the intervention represent some limitations. Indeed, the intervention was conducted in an IT company with specific features that may differ from other workplaces (e.g., the employees' mean age or educational status). This could have affected the results, making it necessary to recommend extending further research to companies with different objectives and organizational charts. In addition, the results were from 8 weeks of intervention, a relatively short time. Even if the results howed a clear positive trend in changing behaviors and perceptions, longer interventions might strengthen the effectiveness of the UP150 concept. Longitudinal studies in different workplaces must confirm and generalize the positive effects on behavior and perception and their long-term preservation.

5. Conclusions

The qualitative analysis of the perception of workers' UP150 experience in the present study confirmed and supported the efficacy of the new-concept worksite office previously investigated by Invernizzi et al. (Invernizzi et al. 2022) as effective for workers' wellbeing, possibly further favoring the return to work at the office after an extended period of remote working after the COVID-19 pandemic. Precisely, an enriched working environment can be created by providing the following: (i) architectural changes, the UP150 App, and wellness coaches' interventions; (ii) a multilevel- and socio-ecologic-based approach, and (iii) the application of the self-determination principles. These actions can efficiently promote physical exercise and address the assumption of healthy behaviors that fit the physical literacy paradigm.

Evaluation and reflection (*Step 6*)

Design and construction studies A and B (*Steps 4 and 5*) highlighted that the UP150 concept design positively impacts employees' psycho-physical wellness, motivation, working routine, and office relationships. Given all the preliminary knowledge (analysis and exploration), to deepen the investigation about the UP150 design efficacy in more realistic contexts, the *Step 6* has investigated the effect of the concept for prolonged periods and in a more realistic hybrid motivational context (people who adhere to and people who do not adhere to the company's policies). Moreover, reflections on the final results and future perspectives have been provided.

Up150 project: a longitudinal analysis of active lifestyles in the complex working system

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Abstract

Workplaces cause employees to adopt sedentary behaviors for most of their daytime, negatively impacting psychophysical health. A new office concept (UP150) was designed to reduce sedentary behaviors at work through architectural changes, proactive technologies, and wellness coaches (education to active lifestyles). The present study examined the effects of the UP150 concept, previously investigated in dedicated workspaces, with a 12-month longitudinal trial in a real worksite environment. Forty-eight desk workers composed experimental (EG) and control (CG) groups. All participants worked in the same working environment, having the UP150 features inserted in a usual working environment, but CG was not allowed to interact with the UP150 specifics. During the experimental year, physical (physical activity, motor efficiency, and anthropometric features), clinical (metabolic parameters and cognitive capacity-related parameters), and psychological (well-being and discomfort, job social and psychological perceptions, and perceived workload) features were assessed. The prolonged application of the UP150 procedure in a mixed working context for involvement in corporate policies positively affected EG workers' physical (physical activity and motor efficiency increased, and body fat unchanged), clinical (blood glucose, insulin, and total cholesterol decreased, HDL increased), and psychological (well-being and social support raised; job demand and perceived workload lowered) parameters, confirming the previous studies.

Keywords: worksite; systems thinking; corporate benefits; physical activity; metabolic health; workers' well-being; psychological health; physical efficiency; sport promotion.

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1. Introduction

The animal kingdom has a peculiar element, the movement, which sets it apart from other living beings (Crapse and Sommer 2008). Therefore, humans have been indissolubly linked to the need for movement to procure food or migrate to more favorable conditions for survival (Dickinson et al. 2000). In industrialized countries, human movement is no longer aimed at satisfying survival needs thanks to technological advancement that first helped lighten physically heavier workloads and was later integrated into everyday life (McNeil 2002). Conversely, it reduced movement and increased daily sedentary behaviors, especially in the desk-worker population (McCrady and Levine 2009).

Therefore, the need for movement has shifted towards avoiding the onset of diseases connected to increasingly endemic sedentary behaviors and maintaining an active physical routine has become the most critical factor in contemporary society's pursuit of optimal lifelong health. Promoting a cultural approach focused on increasing physical activity through education is necessary to establish healthy movement habits that will last until old age. That means developing individual physical literacy, a multidimensional construct that considers motivation to move, body confidence, physical competence, knowledge, understanding of one's body, the effects of physical activity on health, and its impact on everyday life to maintain healthy long-life habits (Herbert 2022). To produce good motor literature acting on individuals' and group's affective, physical, behavioral, and social domains is necessary (Cornish et al. 2020). Hence, disseminating this culture on movement and developing good physical literacy requires considering complex systems that act on multiple aspects of human life.

Systems thinking is a prevailing approach to promoting healthy lifestyles in complex systems (Brennan et al. 2015). This approach considers the actors involved and how they relate to each other and to the phenomena that influence them to create an interpretative "map" from which to start to modify habits and lifestyles by acting on the facilitators (leverage) or opposers (resistance) to the promotion of health interventions (Roxas, Rivera, and Gutierrez 2019). The analysis of multiple and integrated elements facilitates overcoming interpretative diffraction that would make it challenging to integrate physical activity into the typical workflow, which is generally unfamiliar to this context. That said, the systems thinking approach to promoting active lifestyles and maintaining good levels of physical literacy could be helpful if used in a complex system such as workplaces that, from a scientific point of view, are gaining increasing interest as environments targeted to engage a significant number of people and reduce sedentary behaviors (Buckley et al. 2015; World Health Organization and World Economic Forum 2008).

Encouraging active lifestyles in the workplace is part of the worksite health promotion policies that aspire to increase workers' health levels. The most common types of intervention include: i) incorporating specific workout areas located inside the workplace to be used off working hours; ii) providing incentives for off-site fitness centers to attend after work; iii) offering interventions by specialists at the workplace before work, during lunch breaks, after work, or at home (Robroek et al. 2009). Nevertheless, some barriers come from each of these interventions aimed at promoting physical activity: workers' spare time (outside of working hours), scheduling (fitting into daily work commitments), fatigue from long working days (too tired at the end of the day to engage in physical activity), motivation (inadequate perception of the ability to engage in physical activity; Fletcher et al. 2008). An office concept, the UP150 project, has been designed to address the issues pointed out by the literature. It relies on environmental modifications, technological implementation, and support from movement specialists to educate employees on healthy routines and habits to follow during working hours (Invernizzi et al. 2022). This form of employee education reduces sedentary behaviors at the workplace and promotes and disseminates physical literacy among desk workers as part of a lifestyle change process (Figure 1).

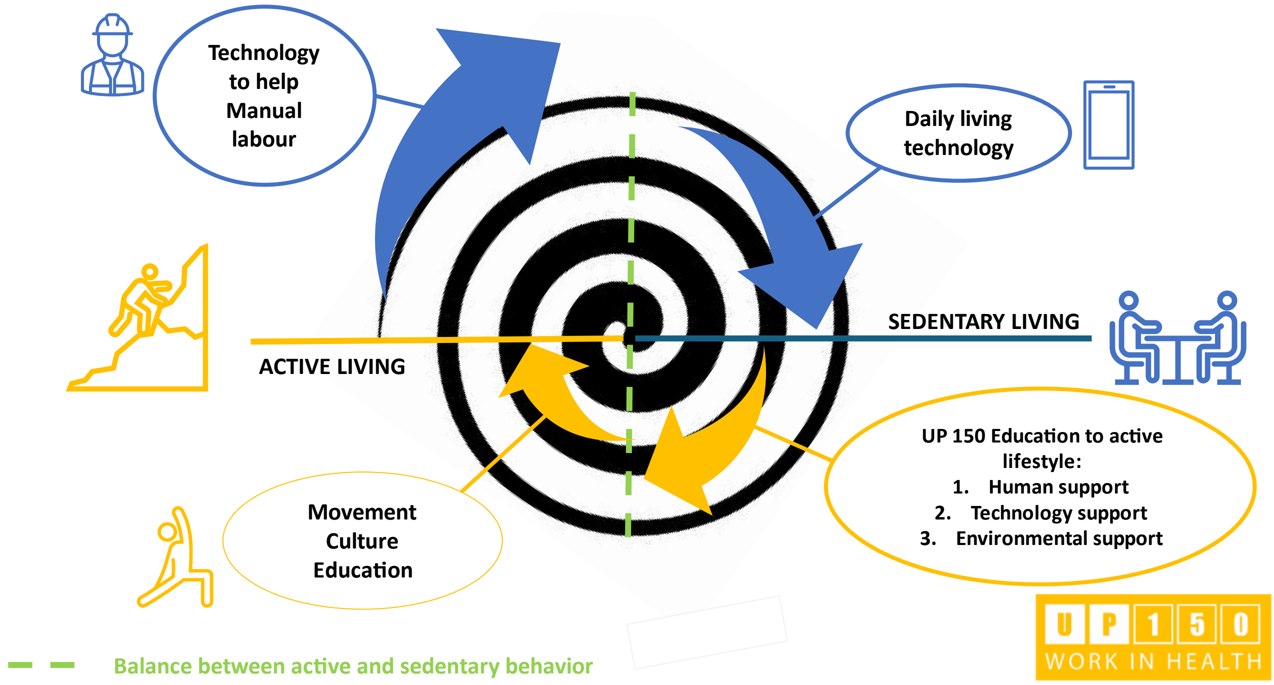

Figure 1. Conceptual spiral of the evolution process of society induced by technological advancement. In blue: technological advancement steps from heavy manual labor (intense physical activity aimed at productivity) to sedentary lifestyles (desk-working). In yellow: steps to recover an adequate amount of workout in the present technologically advanced society (through education on healthy lifestyles using technology and environmental and structural changes to encourage a return to a culture of movement). The dashed green line represents a balance point between active and sedentary behaviors.

The principle underlying the new office concept is the education of employees on healthy routines and habits, starting from the workplace and how the workday is approached. Targeting employees at various levels makes it possible to personalize the experience, motivate, and permanently educate them (Von Korff et al. 1992). However, simply implementing tools and technologies to encourage physical activity in the workplace is not enough to change ingrained sedentary habits, as they are likely to be demotivating in the long term. For this reason, the role of a wellness coach has been incorporated into the UP150 concept, alongside modifying work environments, and introducing dedicated digital apps. The wellness coaches operate as a "contagion," facilitating relationships among colleagues and managers and educating on healthy habits through need-supportive communication, fostering motivational processes linked to the self-determination theory (Deci and Ryan 2000; Fletcher et al. 2008; Yap and Davis 2007).

Previous studies evaluating the effectiveness of the UP150 concept highlighted that this approach already had positive influences after eight weeks of intervention conducted in a controlled environment (experimental group placed in a separate setting from the control group) specifically designed to accommodate employees participating in the study (human and technological environments designed to promote active movements, active breaks, and exercises during typical workflow). Beyond increasing the amount of moderate physical activity, levels of physical efficiency, and mental well-being, participants also increased motivation to adopt active lifestyles and positively changed their work routines (Invernizzi et al. 2022). Furthermore, quantitative (questionnaires) and qualitative (semi-structured interviews) analyses based on employees' perceptions confirmed an improved work environment (Signorini et al. 2022). From these findings, interactions of the effects of the UP150 concept on the office system can be drawn (**Figure 2**, solid lines).

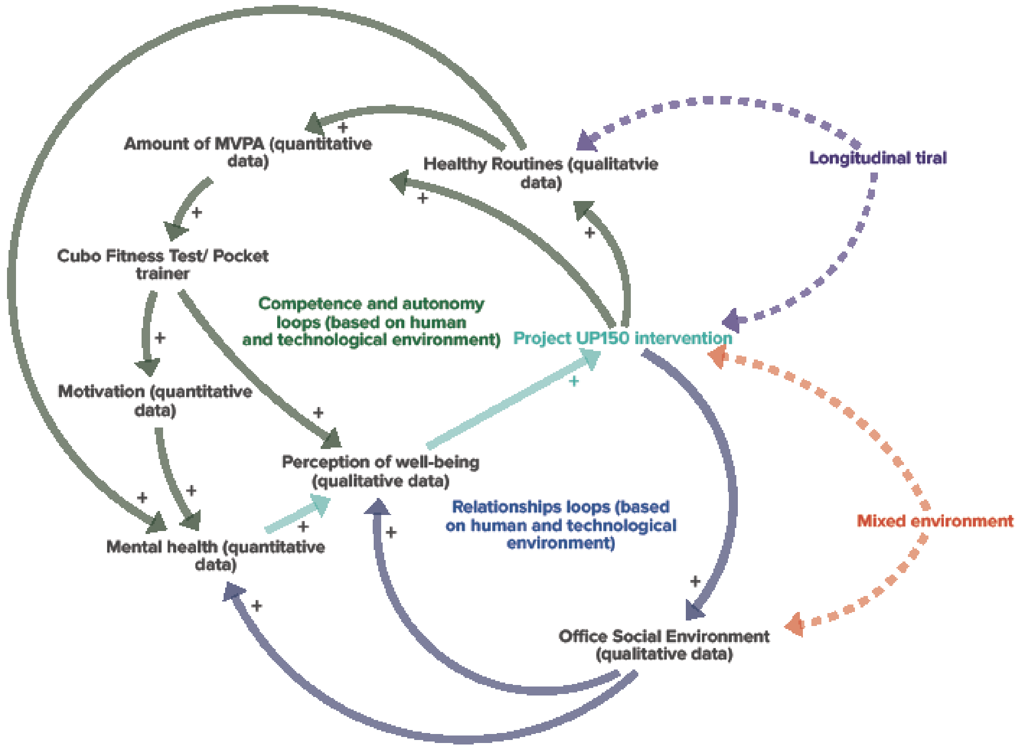

Figure 2. Effects of the UP150 project observed in previous experiments (Signorini et al. 2022) in the office system. Solid lines show interactions between variables (quantitative and qualitative measures). Dashed lines indicate issues that still need to be investigated. The "+" symbols represent an incremental relationship (increase in the phenomenon) between the connected variables.

The UP150 intervention (Figure 2) clearly positively impacted physical efficiency (measured through the Cubo Fitness Test), boosted motivation (as detected by semi-structured interviews), and enhanced the perception of well-being (by increasing levels of perceived physical competence and autonomy in choosing active exercises - Competence and autonomy reinforcing loop - Signorini et al. 2022). This effect is facilitated by improved interpersonal relationships in the office, as reported by participants during the semi-structured interviews. Moreover, a better social environment, positively influencing mental well-being and increasing the perception of overall well-being, further contributed to increasing commitment to the UP150 concept by enhancing the quality of relationships (relationship reinforcing loop). From this perspective, the UP150 concept represents a significant leverage point in promoting active lifestyles in the workplace.

The positive results obtained in a controlled environment during the previous 8-week short-term intervention led to the present study's questioning of whether the UP150 concept can achieve comparable effects over the long term. Therefore, a longitudinal study was conducted in mixed environments of involvement in corporate policies, closer to actual office conditions (both participants involved and not involved in corporate initiatives and policies). The present longitudinal study also aimed to investigate further the effects of the UP150 concept on psychological, job satisfaction-related, cognitive, and metabolic health clinical factors. We hypothesized that evaluating these additional aspects, integrated into systemic thinking (dashed lines, Figure 2), may boost the promotion of active lifestyles in the corporate setting, confirming their long-term positive effects (as a possible leverage point of the system).

2. Methods

2.1. Participants

The sample size for the study was determined by performing a power analysis using the G*Power software. The analysis was conducted by selecting the F test mode, ANOVA: Repeated measures, within-between interaction. Based on a previous 8-week study (Invernizzi et al. 2022), an effect size f of 0.25 and a statistical power of 0.95 were chosen. The minimum sample size was then defined as 32 participants. In the current study, 48 participants were recruited and randomly assigned to the experimental group (EG, 25 participants) and control group (CG, 23 participants). From the control group, 3 participants dropped out during the study due to work-related reasons (job change or company change), resulting in a final sample of 45 participants, 25 belonging to the experimental group (18 males and 7 females) and 20 to the control group (13 males and 7 females). At the beginning of the experiment, participants of EG had a mean age of 39.3 ± 11.0 years and a mean BMI of 23.3 ± 3.7 kg/m^2, while the CG had a mean age of 41.9 ± 10.0 years and a mean BMI of 23.1 ± 3.5 kg/m^2.

2.2. Procedures

The offices of the Progetto CMR company have been modified and implemented with the UP150 concept, consisting of spatial changes, machinery designed to facilitate movement during typical workflow, and workstations equipped with gym tools (active break islands), as described in previous publications (Invernizzi et al. 2022; Signorini et al. 2022). Each participant in the experimental group was assigned a wellness coach whose aim was to motivate physical exercise through supportive communication based on the self-determination theory (Deci and Ryan 1980) and tailor and personalize the participant's experience. Additionally, each worker in the experimental group downloaded a dedicated app (UP150 app) through which goals were set based on the sub-maximal test for physical efficiency (Cubo Fitness Test). Activities were recorded, scores for each activity (based on perceived effort) were calculated, and interaction with workspaces (e.g., activating dedicated stations and functions) was enabled. During the 12-month experimentation period, EG benefited from all components forming the UP150 concept (architectural modifications, app, and wellness coaches), while the control group, even if working in the same environment, did not interact with the concept's components and was not involved in the project (participants continued with their usual work habits simulating a group not involved in company policies).

The local ethics committee approved the study (approval nr. 84/20).

Participants from both groups were familiarized with the tests planned for the experiment. In October 2022 (session #1), all preliminary tests were conducted to measure anthropometric, physical, and psychological features. Measurements were repeated after 6 (in April 2023 – session #3) and 12 months (in October 2023 – session #5). Additionally, intermediate measurements of physical, psychological, and some other features related to occupational psychological well-being (NASA TLX) were conducted 3 and 9 months after session #1 (in January and July 2023, sessions #2 and #4, respectively) to monitoring and appropriately calibrating the psychophysical workload of the EG participants. Furthermore, blood samples were taken during sessions #1 and #5 to observe clinical factors related to metabolic parameters and cognitive capacity. Figure 3 shows the timeline of the intervention.

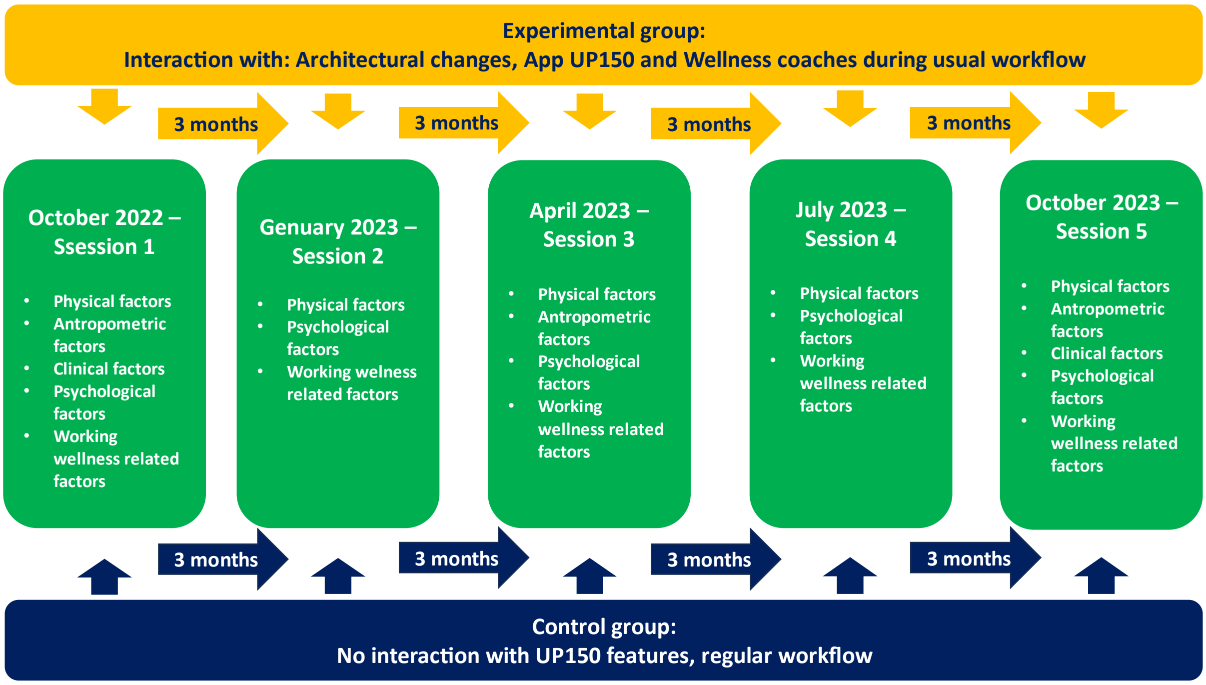

Figure 3. Timeline of the study

2.3. Wellness Coaches training

Wellness coaches (WCs) are professional figures with degrees in sports sciences, specifically trained before the experiment to (i) educate future participants in understanding and using the TQR recovery assessment (Kenttä and Hassmén 1998), the RPE perceived exertion (Borg and Noble 1974), and the Stretch Intensity Scale SIS (Freitas et al. 2015). These scales are necessary for proposing the sub-maximal motor efficiency tests by the Cubo Fitness Test (Invernizzi et al. 2021), educating employees on proper body use through self-perception, and for the conscious use of the UP150 app available to employees to achieve the minimum weekly physical activity score required, adjusting effort intensity appropriately to the situation and one's psychophysical state; (ii) administer the questionnaires; (iii) administer the CFT. WCs were also trained to promote physical activity using supportive communication (need supportive communication, NSC) based on self-determination theory (SDT Deci and Ryan 2012). NSC is an empathetic, flexible, and patient communication style that develops autonomy, competence, and relationships among participants (Ntoumanis et al. 2017). NSC is considered a valuable and effective communication tool for promoting healthy lifestyles and is positively associated with psychological needs satisfaction and psychophysical health, which aligns with the purposes of the UP150 concept (Ntoumanis et al. 2012).

2.4. Measurements

2.4.1. Physical features

Physical Activity. The present study utilized Axivity AX3 triaxial accelerometers (Axivity Ltd., Newcastle upon Tyne, UK, 2013) to objectively measure physical activity and sedentary behavior

(Doherty et al. 2017). Participants wore the accelerometers on the non-dominant hand wrist (Dieu et al. 2017) for a full week, from 5:00 PM on Monday to 8:00 AM the following Monday. The accelerometers were configured to capture acceleration within a range of ±16 g at a data collection frequency of 100 Hz (Arvidsson et al. 2019). The raw triaxial data were retrieved from the devices and exported using OmGUI software version 1.24 (Axivity Ltd., Newcastle upon Tyne, UK, 2013)

Motor Efficiency. The Cubo Fitness Test (CFT) was used to assess the motor efficiency of the participants. It is a test battery consisting of 5 sub-maximal tests based on perceived exertion and muscle stretching aimed at assessing cardiorespiratory (RU, Ruffier test Gabriele Papini et al. 2017), muscular (PU, push-up and SU, sit-up tests; Crotti et al. 2018; Invernizzi et al. 2020), and joint fitness (SM, shoulder mobility (Harre 1977), and S&R, sit and reach test Jones et al. 1998). The tests returned a motor efficiency index (IME) ranging from 10 to 100 and a weekly physical activity score (WPAS). The IME is the sum of the results obtained in the individual tests normalized for sex and age. A score below 33 points is considered low, between 33 and 66 is considered moderate, and above 66 is considered high. The WPAS is the score to be achieved weekly regarding physical activity and is calculated based on IME, age, and sex. To reach the weekly WPAS, points must be accumulated through physical activities. Each physical activity assigns a score, which is the product of the minutes of activity by a coefficient relative to the perceived intensity on the adapted Borg scale (light perceived activities, with effort values <=3, have a coefficient of 0.5; moderate activities, effort values between 4 and 6, have a coefficient of 1; vigorous activities, effort values >6, have a coefficient of 2, i.e., a continuous running session of 30 minutes, perceived as vigorous, accounts/gives for 60 points). The procedures of the CFT, as well as its validity and reliability, are detailed and confirmed in previous research (Crotti et al. 2018; Invernizzi et al. 2021, 2022; Signorini et al. 2023).

Anthropometric features. Weight, height, BMI, and body composition were collected. Weight and height were measured using a mechanical scale with an altimeter (Seca 700; Seca North America East, Hanover, MD, USA) with a sensitivity close to 0.1 kg for the scale and 0.1 cm for the altimeter. BMI was calculated using the formula kg/m^2. Body composition was estimated through skinfold thickness measurements. The measurement was performed using a mechanical skinfold caliper (GIMA skinfold caliper– 27320, Gessate, Milano, Italia) calibrated with a sensitivity of 0.2 mm. The body fat percentage was estimated using the Durnin-Womersley formula, commonly used in literature to estimate body composition even in sedentary populations (Durnin and Womersley 1974; Peterson, Czerwinski, and Siervogel 2003). Skinfold measurements were taken at 4 body sites: biceps, triceps, supra iliac, and subscapular. The values, based on age and sex, were inserted into predictive equations for estimating body density. Subsequently, Siri's formula (Siri 1956) was used to estimate fat mass. All anthropometric measurements were performed by the same operator, in the same room, with a temperature of 20°C and humidity of 40%.

2.4.2. Clinical features

Metabolic parameters. Blood samples (22.5) mL were taken sitting via standard antecubital venipuncture. All samples were preserved on ice until plasma or serum centrifugation at 4 °C (within 1.5 h from sampling). Plasma and serum were frozen at −60 °C for later analysis in duplicate. A glucose analyzer measured plasma glucose (Beckman Instruments, Fullerton, CA, USA). Free insulin was dosed via a highly specific two-site monoclonal antibody-based immunosorbent assay (ELISA; Dako Diagnostics, Cambridgeshire, UK). A commercial ELISA kit served to measure plasma cortisol. A Beckman DXC 700 AU Coulter analyzer detected creatinine, cholesterol, and triglycerides.

Blood factors related to Cognitive capacity. Levels of BDNF, NGF, and VEGF were measured using 50 ml of plasma for BDNF and 100 ml of plasma for NGF and VEGF through the following ELISA kit: human BDNF (Brain-Derived Neurotrophic Factor) ELISA kit, human NGF (Nerve Growth Factor) ELISA kit, and human VEGF-A (Vascular Endothelial Cell Growth Factor A) ELISA kit (Elabscience, Houston, TX, USA). Reported intra and inter-assay coefficients of variation were <10%. The reported sensitivity was 18.75 pg/ml for BDNF ELISA kit, 9.39 pg/ml for NGF ELISA kit, and 18.75 pg/ml for VEGF-A ELISA kit. Data were acquired through the microplate reader Victor 2 Wallac 1420 (Perkin Elmer, Waltham, MA, USA).

2.4.3. Psychological features

Wellbeing and discomfort. Because of its reliability and validity in assessing individuals' self-perception of their overall well-being and discomfort, the Psychological General Well-Being Index (PGWBI) was administered to participants (Chassany et al. 2004; Dupuy 1984). The PGWBI consists of 22 items rated on a 6-point Likert scale that explores 6 dimensions: anxiety, depressive mood, positive well-being, self-control, general health, and vitality. The total sum of all the items is utilized to create an overall general well-being index. In this study, the validated Italian version of the PGWBI was employed (Grossi et al. 2002).

2.4.3.1. Workplace psychological wellness features

Perceived workload. The NASA Task Load Index (NASA TLX) was used to investigate the perceived workload related to the employees' working activity (Hart 2006; Hart and Staveland 1988). It assesses the workload associated with the previous working week (Hoonakker et al. 2011; Invernizzi et al. 2022) considering six domains: mental demand (MD), physical demand (PD), temporal demand (TD), effort (EF), performance (PE), and frustration (FR). A total score (TS) is calculated based on each domain's result. TS summarizes the overall workload.

Job social and psychological perceptions. We used the Job Content Questionnaire (JCQ) to measure job social and psychological characteristics. In the present research, we utilized the adapted and validated Italian version, consisting of 49 questions based on a 4 to 5-point Likert scale and some open questions assessing three main job characteristics: decision latitude, psychological demands, and social support (Baldasseroni et al. 2001; Karasek and Theorell 1990). Decision latitude refers to the opportunity to learn new things, the repetitiveness of tasks, the opportunity to utilize one's competencies, and the level of job organizational leeway; job demands refer to the required physical and psychological work commitment; social support refers to the working support from coworkers and supervisors (Baldasseroni et al. 2001; Karasek 1990; Karasek and Theorell 1990).

2.5. Statistical analysis

The normality of the data was verified using the Kolmogorov-Smirnov test and by evaluating the Skewness and Kurtosis (Kim 2013). All measurements related to anthropometric factors (weight, height, BMI, and skinfold thickness measurements) and psychological factors (PGWBI and General Self-efficacy), along with the JCQ, were analyzed using a 3x2 ANOVA (time x group). Measurements related to physical factors (physical activity, CFT) and NASA TLX were instead analyzed using a 5x2 ANOVA (time x group). Post-hoc analysis was performed for both tests using unpaired t-tests with the Holm-Bonferroni correction. Regarding clinical factors, paired t-tests comparing CG and EG sessions #1 and #5 and unpaired t-tests comparing EG and CG deltas (session #5 – session #1) were conducted. When data normality was not confirmed, group comparisons were conducted using the Mann-Whitney U test (EG vs CG), while intra-group comparisons were performed using the

Friedman test. An alpha value of 0.05 was set for all analyses. The effect size, partial eta squared, calculated for ANOVA, was interpreted using the following cutoffs: 0.01 = small, 0.06 = medium, 0.14 = large (Bakeman 2005). The effect size for t-tests (parametric and non-parametric) was calculated using Cohen's d with the following cutoffs: 0.1 = small, 0.3 = medium, 0.5 = large (Cohen 2013).

3. Results

3.1. Physical Features

The analysis of the results related to the amount of physical activity measured through the accelerometer showed no significant interactions regarding light physical activity (Figure 4, panel a). However, a group effect can be observed ($F = 18.505$, $\eta p2 = 0.098$, $p < 0.0001$). Moderate physical activity (Figure 4, panel b), instead, showed a tendency towards a significant time*group interaction ($F = 2.332$, $\eta_p^2 = 0.052$, $p = 0.058$) and a significant group effect ($F = 14.787$, $\eta_p^2 = 0.099$, $p < 0.0001$). For vigorous physical activity (Figure 4, panel c), the non-parametric test revealed differences in session #4 ($p = 0.038$, $d = 0.30$) and #5 ($p = 0.031$, $d = 0.31$).

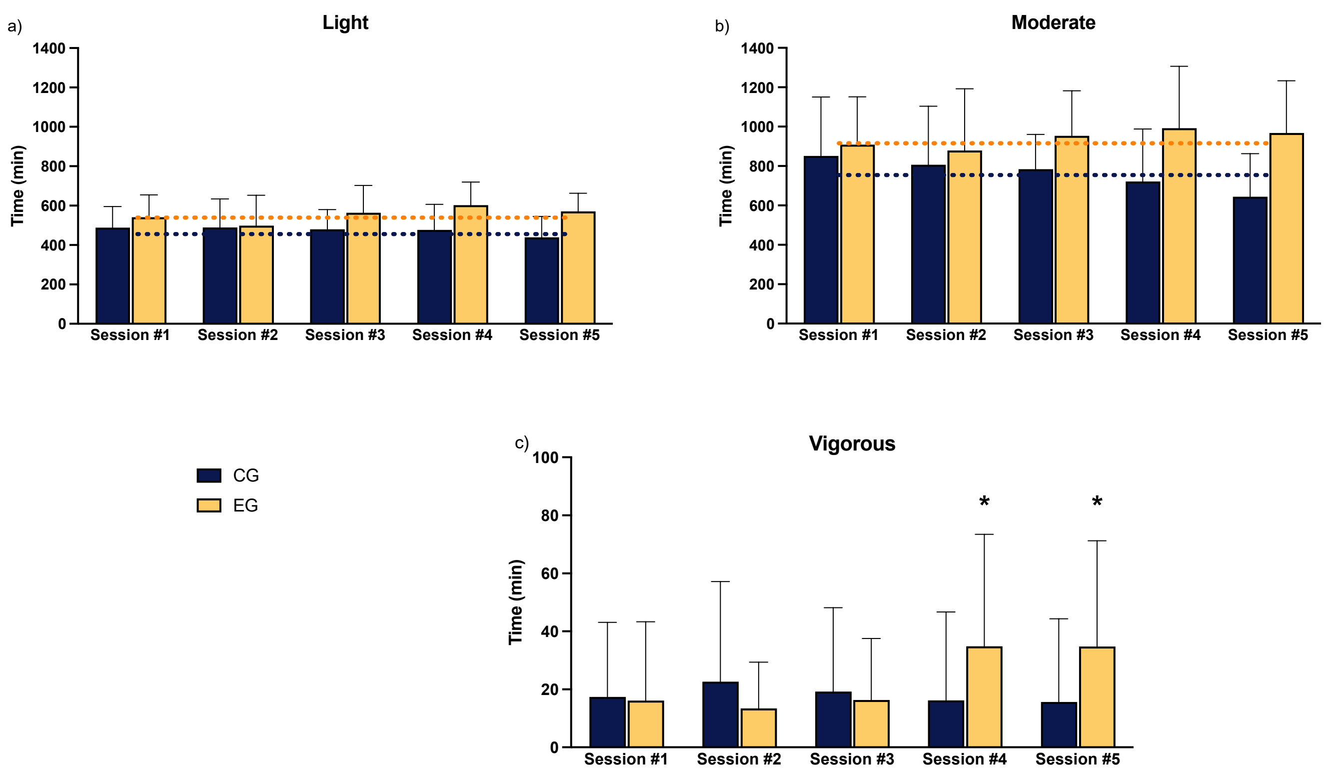

Figure 4. Weekly physical activity (minutes). Panel a: light activity; panel b: moderate activity; panel c: vigorous activity. The dotted lines represent the significant group effect. * = significantly different than CG ($p<0.05$).

Regarding the results of the CFT (Table 1), the RU did not show interaction but a significant group effect ($F = 36.226$, $\eta p2 = 0.9$, $p = 0.004$). The PU and SU tests did not have normally distributed scores; the non-parametric analysis reported significantly higher scores for EG in sessions #3 (PU: p

= 0.001, d = 0.48; SU: p = 0.041, d = 0.29), #4 (PU: p = 0.016, d = 0.35; SU: p = 0.022, d = 0.33), and #5 (PU: p = 0.001, d = 0.51; SU: p = 0.018, d = 0.34), in both tests. In the S&R test (Figure 5), a significant interaction was detected (F = 3.288, ηp2 = 0.07, p = 0.012), and the post hoc test revealed a difference between groups in session #5 (p = 0.007, d = 0.90). No interactions or significant effects were found in the SM test, while a significant group effect was detected for IME (F = 14.718, ηp2 = 0.075, p < 0.0001). Figure 5 shows the trend of results displaying significant interaction.

Table 1. Physical efficiency (Cubo Fitness Test).

Time point	Group	RU (au) #	PU (au)	SU (au)	SM (cm)	S&R (cm) §	IME (au) #
Session #1	EG	7.8 ± 2.9	3.6 ± 1.6	6.7 ± 3.8	53.5 ± 8.4	-1.6 ± 9.3	51.6 ± 11.0
	CG	9.4 ± 2.9	3.3 ± 1.8	5.4 ± 2.4	50.5 ± 12.1	-6.8 ± 9.5	48.1 ± 9.3
Session #2	EG	7.1 ± 4.2	4.7 ± 3.1	7.0 ± 4.2	56.3 ± 8.4	-3.8 ± 9.8	48.5 ± 15.9
	CG	9.0 ± 2.9	3.1 ± 1.3	5.6 ± 3.6	51.3 ± 10.8	-1.1 ± 9.4	46.6 ± 10.4
Session #3	EG	6.8 ± 3.3	5.4 ± 2.6*	8.0 ± 4.1*	52.9 ± 9.2	-1.5 ± 9.7	56.3 ± 11.8
	CG	8.1 ± 3.1	3.1 ± 1.3	5.4 ± 2.0	51.3 ± 11.0	-3.8 ± 10.9	49.8 ± 10.0
Session #4	EG	5.8 ± 2.1	5.4 ± 2.6*	7.7 ± 4.1*	53.5 ± 9.2	-1.1 ± 9.6	57.9 ± 11.3
	CG	8.5 ± 3.3	3.2 ± 1.3	4.9 ± 1.9	50.7 ± 11.1	-6.2 ± 11.2	49.0 ± 8.0
Session #5	EG	6.1 ± 2.7	5.4 ± 3.6*	8.3 ± 4.1*	53.0 ± 8.8	2.2 ± 9.4*	57.1 ± 10.4
	CG	9.3 ± 3.6	3.2 ± 1.3	5.2 ± 2.1	52.4 ± 12.4	-7.6 ± 12.2	46.4 ± 10.6

EG = experimental group, CG = control group, RU = Ruffier test, PU = push-up test, SU = sit-up test, SM = shoulder mobility, S&R = sit and reach test, IME = index of motor efficiency. Significantly different than CG: * = p<0.05. Significant interaction (time*group): § = p<0.05. Significant group effect: # = p < 0.05

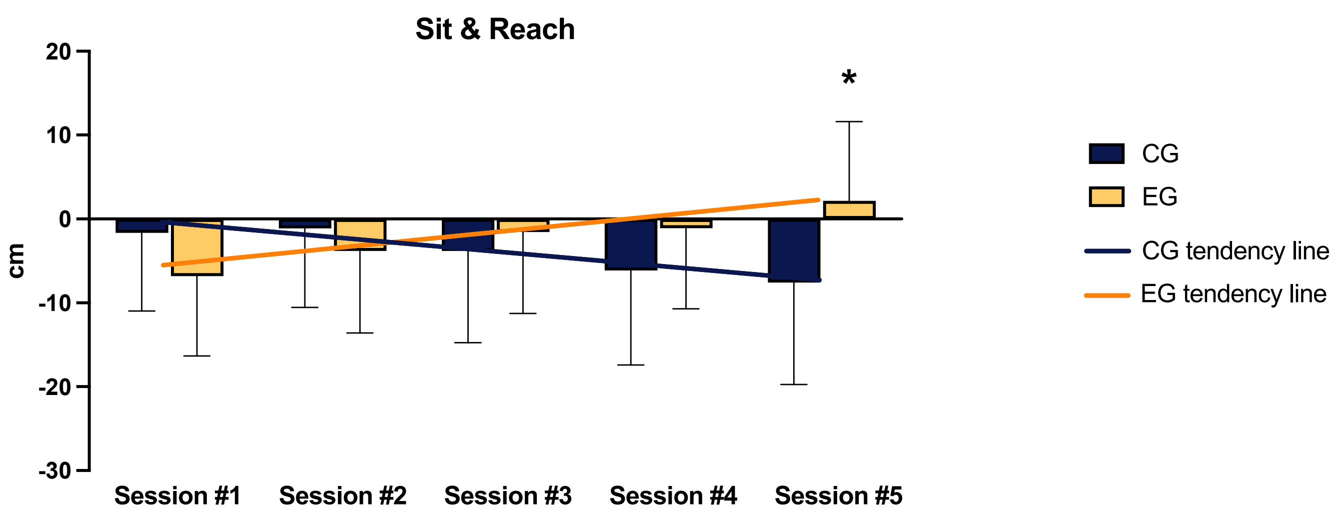

Figure 5. Sit & Reach test results. Significantly different than CG: * = p<0.05. The lines represent the time*group effects (interactions).

The observation of the anthropometric features did not reveal any interaction or effect concerning the measurements related to BMI. However, the body fat percentage calculated by the skinfold measurement showed a significant group effect ($F = 19.988$, $\eta p2 = 0.146$, $p < 0.0001$). The results are reported in Table 2.

Table 2. Body composition.

	Session #1		**Session #3**		**Session #5**	
	EG	CG	EG	CG	EG	CG
BMI (Kg/m^2)	23.3 ± 3.7	23.1 ± 3.5	23.4 ± 3.7	23.3 ± 3.5	23.2 ± 3.8	23.1 ± 3.5
% Body Fat #	25.5 ± 6.0	27.2 ± 6.5	25.6 ± 6.2	28.4 ± 7.0	24.7 ± 6.1	27.4 ± 7.4

EG = experimental group, CG = control group. Significant group effect: # = p < 0.05.

3.2. Clinical features

The complete clinical features analysis is reported in Table 3. Specifically, the comparison of the deltas (sessions #5 - #1) between EG and CG showed better significant values of EG glucose values ($p = 0.021$, $d = 0.92$), insulin ($p = 0.005$, $d = 1.15$), total cholesterol ($p = 0.003$, $d = 1.34$), triglycerides ($p < 0.0001$, $d = 1.33$), and HDL ($p = 0.029$, $d = 0.88$). Regarding parameters related to cognitive capacity-related parameters, significant differences were found in favor of EG only in the VEFG delta values ($p < 0.0001$, $d = 1.6$).

Table 3. Clinical features.

	EG		**CG**		**Delta (#5 - #1)**	
	Session #1	**Session #5**	**Session #1**	**Session #5**	**EG**	**CG**
Creatinine (mg/dl)	0.92±0.20	0.84±0.22*	0.86±0.12	0.77±0.16*	-0.09±0.06	-0.08±0.08
Glucose (mg/dl)	83.4±7.65	75.20±6.32*	81.92±8.95	83.77±8.17	-6.53±5.94 §	-0.08±7.90
Insulin (µU/mL)	5.45±1.85	4.22±1.22*	6.80±7.68	7.18±8.08	-1.11±1.04 §	0.23±1.27
Total cholesterol (mg/dl)	186.67±27.05	172.07±21.18*	206.92±56.31	211.85±61.10	-14.87±7.80 §	5.23±19.63
Triglycerides (mg/dl)	82.93±29.65	76.67±25.46*	86.00±47.89	110.62±47.27*	-1.93±12.92 §	19.62± 8.90
HDL (mg/dl)	60.00±11.64	64.33±11.99*	67.38±16.33	62.38±14.39*	2.80±7.02 §	-3.23±6.67
Cortisol (mcg/dl)	15.71±9.88	12.50±8.03*	11.82±2.61	14.50±6.52	-2.48±3.70	1.83±7.84
BDNF (pg/ml)	8495.7±2081.9	7778.9±2818.0	8880.6±2603.2	7412.3±2818.8*	-716.8±2242.3	-1468.3±2261.5
VEGF (pg /ml)	162.2±118.9	252.2±182.5*	223.0±98.7	139.1±73.8*	90.0±128.4 §	-83.8±84.0
NGF (pg/ml)	153.1±261.2	74.9±146.6	143.4±234.0	182.1±289.6	-78.2±198.2	38.7±203.5

EG = experimental group, CG = control group. HDL = high-density lipoproteins, BDNF = brain-derived neurotrophic factor, VEGF = Vascular endothelial growth factor, and NGF = nerve growth factor. * = significantly different than Session #1 in paired t-test (p<0.05); § = significantly different than CG in unpaired t-test (p<0.05).

3.3. Psychological features

In Figure 6, the results of the PGWBI questionnaire are presented. Significant interactions were found in positivity ($F = 8.505$, $\eta p2 = 0.145$, $p < 0.0001$), vitality ($F = 5.539$, $\eta p2 = 0.101$, $p = 0.005$), and overall score ($F = 3.415$, $\eta p2 = 0.065$, $p = 0.037$), indicating a positive trend in favor of EG. Post hoc analysis showed significant variations between EG and CG in positivity in sessions #3 ($p = 0.025$, $d = 0.86$) and #5 ($p = 0.017$, $d = 1.64$), and in vitality ($p = 0.017$, $d = 0.96$) and the total score ($p = 0.017$, $d = 0.90$) in session #5. The general health category was analyzed using a non-parametric test due to non-normal distribution, which revealed significant differences in favor of EG in sessions #3 ($p = 0.021$, $d = 0.34$) and #5 ($p = 0.001$, $d = 0.48$).

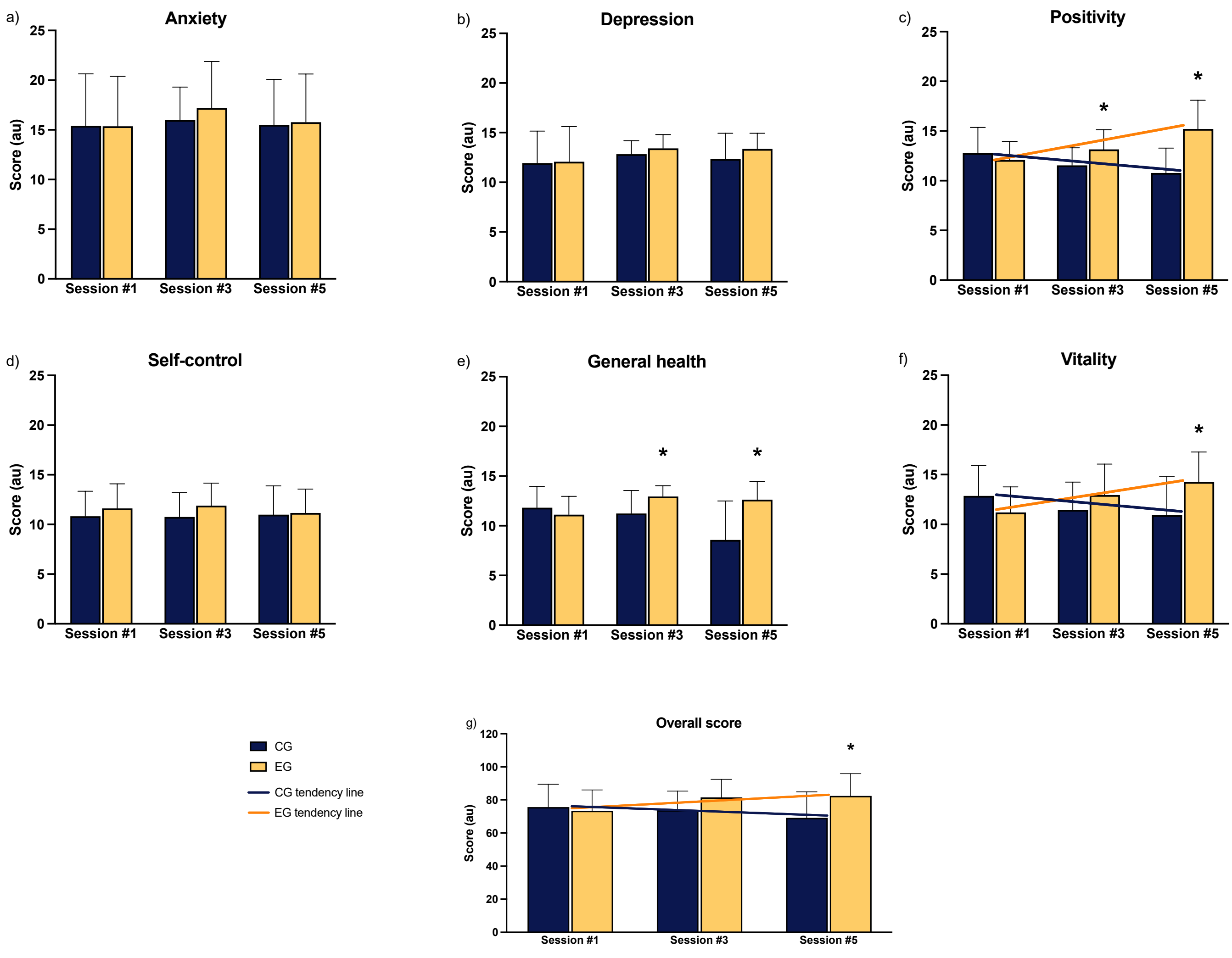

Figure 6. Results of the PGWBI questionnaire.: Significantly different than CG * = p<0.05. The lines represent the time*group effects (interactions).

3.3.1. Workplace psychological wellness features

A significant time effect (F = 13.282, ηp2 = 0.186, p < 0.0001) was observed in the decision latitude of the JCQ (Table 4), even if without a significant interaction. Job demand showed a significant interaction (F = 10.985, ηp2 = 0.158, p < 0.0001) with post-hoc differences between EG and CG in session #5 (p = 0.017, d = 1.28). Values related to social support were analyzed using a non-parametric analysis and showed significant differences in favor of EG in session #5 (p < 0.0001, d = 0.56).

Table 4. Job Content Questionnaire's results.

	Session #1		Session #3		Session #5	
	EG	CG	EG	CG	EG	CG
Decision latitude (au) ⸸	77.5 ± 7.5	73.9 ± 10.6	76.8 ± 8.1	72.2 ± 6.0	61.2 ± 25.4	58.9 ± 19.8
Job demand (au) §	36.1 ± 3.7	34.5 ± 2.4	32.3 ± 6.0	34.4 ± 3.6	21.0 ± 12.8*	33.5 ± 5.1
Social support (au)	19.7 ± 5.9	23.1 ± 5.2	23.7 ± 3.9	25.4 ± 4.8	25.7 ± 3.3*	20.2 ± 4.4

Time points: session #1: October 2022; session 3#: April 2023; session #5: October 2023. EG = experimental group, CG = control group. Significantly different than CG: * = p<0.05. Time*group interaction: § = p<0.05. Significant time effect: ⸸ = p<0.05

The results related to workload (Table 5) indicate a significant interaction in mental demand (F = 2.794, ηp2 = 0.06, p = 0.028). However, the post-hoc analysis did not reveal significant differences between groups, even if data values of EG seem to have a decreasing trend, contrary to CG results that increase, which explains the observed interaction. No interactions or significant effects were found for the other NASA TLX parameters except for the effort, having a significant group effect (F = 6.383, ηp2 = 0.012, p = 0.035).

Table 5. Workload (NASA TLX).

Time point	Group	MD (au) §	PD (au)	TD (au)	PE (au)	EF (au) #	FR (au)	WS (au)
Session #1	EG	74.0 ± 17.7	11.5 ± 12.6	44.7 ± 24.7	34.7 ± 18.3	26.7 ± 18.0	6.9 ± 10.6	13.2 ± 2.8
	CG	61.9 ± 23.9	7.5 ± 8.0	43.2 ± 21.2	31.1 ± 17.7	29.4 ± 20.7	4.6 ± 7.4	11.8 ± 3.5
Session #2	EG	62.8 ± 19.8	9.1 ± 10.6	52.4 ± 23.4	35.8 ± 26.7	25.6 ± 18.6	14.4 ± 24.9	13.3 ± 3.4
	CG	55.1 ± 15.6	11.7 ± 11.2	44.0 ±23.7	28.5 ± 22.7	27.9 ± 15.5	13.1 ± 24.1	12.0 ± 2.0
Session #3	EG	65.8 ± 22.9	11.0 ± 16.1	48.9 ± 18.9	23.3 ± 13.9	30.3 ± 20.0	13.6 ± 23.1	12.9 ± 3.2
	CG	60.6 ± 27.4	11.2 ± 15.8	43.6 ± 21.7	21.2 ± 12.8	26.1 ± 20.4	7.3 ± 9.5	11.3 ± 2.0
Session #4	EG	53.3 ± 22.9	8.2 ± 10.0	50.3 ± 18.7	34.7 ± 21.9	22.3 ± 15.9	12.3 ± 16.6	12.1 ± 3.3
	CG	67.2 ± 23.2	6.1 ± 10.1	46.3 ± 27.0	22.3 ± 13.6	29.2 ± 23.8	19.7 ± 25.9	12.8 ± 2.9
Session #5	EG	59.2 ± 16.9	7.3 ± 9.9	51.2 ± 19.7	23.1 ± 14.0	28.6 ± 21.4	15.8 ± 18.1	12.3 ± 2.3
	CG	73.3 ± 25.9	16.6 ± 20.9	48.6 ± 25.7	22.8 ± 10.0	36.8 ± 27.1	8.2 ± 15.5	13.7 ± 2.6

EG = experimental group, CG = control group, MD = mental demand, PD = physical demand, TD = temporal demand, PE = performance, EF = Effort, FR = Frustration, WS =Weighted sum. Significantly different than CG: * = $p<0.05$. Significant interaction (time*group): § = $p<0.05$. Significant group effect: # = $p<0.05$

4. Discussion

This study investigated the effects of the UP150 project in a 12-month longitudinal trial in a mixed environment (i.e., involving engagement with company policies related to the UP150 project). From a system thinking perspective, the study evaluated how the UP150 concept impacts employees' physical, clinical, psychological, and work-related well-being factors thanks to actions promoting education to move.

4.1. Physical Features

Physical Activity. During this longitudinal study, experimental group participants gradually increased the amount of physical activity performed. The analysis revealed that EG performed more light and moderate physical activity during the experimentation year. Moreover, in the last two experimental sessions (#4 and #5) EG resulted in more vigorous physical activity compared to CG. As expected, UP150 effectively promoted light and moderate-intensity physical activity, consistent with previous studies (Invernizzi et al. 2022) and coherently with other workplace interventions (Mullane et al. 2017). As per the protocol, wellness coaches are tasked with promoting active lifestyles using tools such as the UP150 app and CFT, which, through perceived exertion, allow employees to achieve the minimum amount of physical activity recommended by the WHO (150 min/week of moderate physical activity or 75 min/week of vigorous physical activity World Health Organization 2018). After the second month, the results indicate that participants exceeded the expected weekly score and maintained a steady trend throughout the experiment (Figure 7).

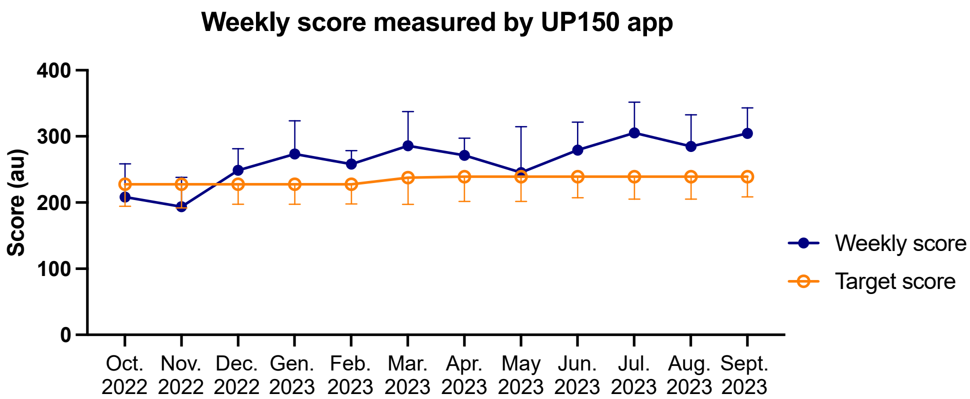

Figure 7. The trend of weekly scores of the experimental group participants throughout the first year of intervention, as recorded by the UP150 app. The performed weekly score is the average of the weekly scores achieved by the participants during each month. The target weekly score represents the average of the target scores EG should reach weekly, determined by the baseline testing with the CFT.

All exercises in the office recommended by the wellness coaches were to be performed with a perception of effort from light to moderate to avoid conflicting with work demands (excessive sweating, excessive vigor in a formal environment, or risk of injuries). Light activities increased as moderate activities, likely due to the gradual incorporation of active micro-breaks into the new resulting work routines, allowing to integrate into the workday more activity in less time (e.g., completing joint mobility light activities in just one to three minutes). Furthermore, wellness coaches supplied recommendations and motivation for physical activity and healthy lifestyles outside working hours through need-supportive communication by digital technology, further recommending vigorous activities.

The trend of improvements could indicate that light and moderate activities, primarily promoted by the coaches and practicable in the office, first impacted EG employees. Instead, the employees probably autonomously integrated vigorous activities outside the workplace in the last months of the trial. In summary, the overall trend of the results related to the amount of physical activity suggests that the motivation to move originated in the workplace thanks to direct involvement by the wellness coach and later developed into an autonomous intention to exercise not only within but also outside the workplace (self-dependent activities fostered by the wellness coaches; Dagenais-Desmarais et al. 2014; Kinnafick, Thøgersen-Ntoumani, and Duda 2016). The CFT results confirm this trend: although the significant interaction suggests a constant improvement in parameters related to joint mobility, significant improvements compared to CG first appeared in muscular fitness, starting from the third measurement session (at mid-experimentation). Afterward, significant improvements were also found in cardiorespiratory fitness. Finally, summing up all results, a general improvement in motor efficiency (IME) was observed, leading EG to outperform CG.

It is still being determined which fitness exercises the employees performed the most frequently. However, this improvement is linked to increased exercise performed by EG participants, consistent with the literature (Ferreira et al. 2012).

Anthropometric features. All participants started from an average condition of normal weight and body fat percentages within the recommended ranges for health (Gallagher et al. 2000; Zhu et al. 2003). Despite this, the intervention has had positive effects on body composition parameters. The body fat percentage trend observation shows that initial values were comparable at mid-experimentation and slightly reduced at the end of experimentation in EG. Differently, CG slightly increased their body fat percentage, producing significant differences between the groups. This effect is expected if we consider the increase in the weekly physical activity performed by the EG, predominantly at moderate intensity. As highlighted Winters et al. (Winters-van Eekelen et al. 2021), weight control can be facilitated by reducing the time spent in sedentary activities and increasing moderate to vigorous physical activity (MVPA). According to this study, 30 more minutes per week of MVPA reduced total body fat percentage by 1.3% (participants had a BMI of 27 kg/m² or higher). In our case (with normal-weight participants), an average increase of 78 minutes per week of MVPA (+60 minutes of moderate activity and +18 minutes of vigorous activity) reduced body fat by 0.8%.

4.2. Clinical features

Consistently with what has been previously highlighted, the delta analysis showed that after the experimentation, EG participants had significantly higher improvements in metabolic clinical parameters compared to CG. Specifically, the EG improved blood glucose, total circulating cholesterol, insulin, triglycerides, and HDL levels. These findings and improvements of all EG parameters between sessions #1 and #5 confirm that engaging in a minimum weekly physical activity can positively impact health and certain metabolic parameters associated with metabolic syndrome (World Health Organization 2018). The study data also suggest that these positive effects can be achieved even with short active breaks of less than 10 minutes, as previously found in the literature (Guhanarayan, Jablonski, and Witkowski 2014).

Regarding blood factors related to cognitive capacity the increase in moderate-intensity physical activity and its spreading throughout the day may have positively influenced EG's VEGF, as reported by literature (Gustafsson et al. 2001; Shaaban et al. 2019). However, there were no positive effects on the other two parameters measured (BDNF and NGF). We hypothesize that this is possibly due to the short duration of active breaks, which resulted in insufficient to modify them. Nevertheless, vascular development could still have brought benefits to the brain, as it is associated with better oxygen diffusion in tissues, which helps prevent neurodegenerative diseases like Alzheimer's (Mateo et al. 2007).

4.3. Psychological features

As in a previous 8-week study (Invernizzi et al. 2022), the longitudinal intervention brought psychological and mental health benefits. From the PGWBI, it is noted that from session #3 (6 months from the beginning of the intervention), general health and positivity are higher in EG than in CG, and, at the end of the intervention, the same resulted in vitality. Two explanations can be adduced: the coping aspects of the low-intensity physical exercise performed in pauses during the workflow and the communicative procedures used by wellness coaches based on self-determination theory (need-supportive communication; Ntoumanis et al. 2017). Several studies have shown that low-intensity exercise can reduce or help manage stress (Cramer, Nieman, and Lee 1991; Gerber et al. 2020) and increase vitality (Strijk et al. 2013). From a cognitive point of view, vitality carries an increased sense of well-being, lower levels of mental fatigue, and greater resilience and perseverance. Research conducted in the work environment has found that augmented positivity and vitality can increase productivity and involvement, reducing the risk of burnout (Lambert et al. 2019). In addition, the need-supportive communication based on the self-determination theory used by wellness coaches has been proven effective in increasing mental well-being, even in the workplace, by acting on the sense of autonomy, competence, and mutually satisfying relationships (Dagenais-Desmarais et al. 2014).

4.3.1. Workplace psychological wellness features

The mental well-being of employees is also reflected in factors related to working well-being. The analysis of the JCQ outcomes reveals a lower perception of the workload of the EG employees compared to the control. Moreover, at the end of the longitudinal intervention, employees who took an active part in the UP150 concept reported higher levels of social support, a value linked to collaboration in the workplace. The reduced perception of workload could originate from the change in the working paradigm experienced by employees who moved from a standard model providing a few coded macro-breaks (for example, lunch or coffee break) to a new model (the UP150) inserting active micro-breaks spread throughout the day (1 to 5 minutes about every 60 minutes). This would have positively affected their perception of well-being, in line with Radwan and colleagues' findings (Radwan et al. 2022). The gradual reduction in mental demand for EG, as seen from the NASA TLX outcomes, further supports this occurrence. In the previous UP150 study, this parameter also improved after intervention, confirming significantly lower levels of mental demand of participants experiencing intervention. Thanks to the consolidation of the active routines in the workplace, this perceptive modification could have led employees to report less work effort in the NASA TLX questionnaire.

The improved social support parameter could originate from the wellness coach's support based on self-determination theory. Indeed, from the semi-structured interview conducted in the previous 8-week UP150 study, employees already reported an advance in the relational climate in the working environment favored by wellness coaches through active group breaks or moments of informative workshops (Signorini et al. 2022; Taylor 2005). In line with the literature (Ginoux, Isoard-Gautheur, and Sarrazin 2019), the effectiveness of the UP150 concept in creating meaningful relationships with the social environment and a sense of acceptance within the working environment through need-supportive communication is confirmed.

4.4. Summary

Although several outcomes of this study confirm the results from a previous study (Invernizzi et al. 2022), the two studies differ in the temporal span necessary to detect changes. In this research, noticing significant differences between EG and CG required, for many outcomes, a minimum of six months of intervention, while, in Invernizzi's study, the first results in physical (physical efficiency and physical activity) and psychological features (health status and workload) appeared after two months. This discrepancy can be explained by the different setting aspects in which the two experiments were carried out. In the first study, the worksite was specifically created to host the experiment, and only the experimental participants worked in it; in the present study, both the EG and CG participants worked together in the same office that was implemented with architectural changes, but in which the control did not follow the UP150 concept. This mixed environment, corresponding to the actual condition of reality where the concept could be inserted in the future, could have generated more resistance to changes because of social conditioning (Dickerson, Gruenewald, and Kemeny 2004). In Figure 7, the inertia in achieving the weekly score in the first two months of intervention can be easily noticed. In mixed environments about motivation to exercise, active breaks may be unusual and not understood if not perceived as disrupting and interrupting the work task by those not involved in the specific UP150 project. The preservation mechanism of the social self (i.e., self-image within the group, social status, social esteem, and group acceptance) leads the individual to preserve himself from situations that the group may not accept, thus leading to sensations of shame (Dickerson et al. 2004). From a system thinking perspective, the presence of mixed environments for involvement in physical activity could be a point of resistance that leads to increased time needed to educate employees to adopt healthy lifestyles and receive the resulting benefits.

Figure 8 shows how a mixed environment and a longitudinal intervention fit into the UP150 system thinking. The mixed environment (the limited participation of employees in company policies) slows down the occurrence of potential positive effects, which requires an initial period of adaptation to reach regime levels (in our case, two months, as in Figure 7). Despite this, the UP150 concept benefited from the long duration of the intervention, preserving motivation to exercise and establishing ongoing improvements throughout the twelve months of protocol supply.

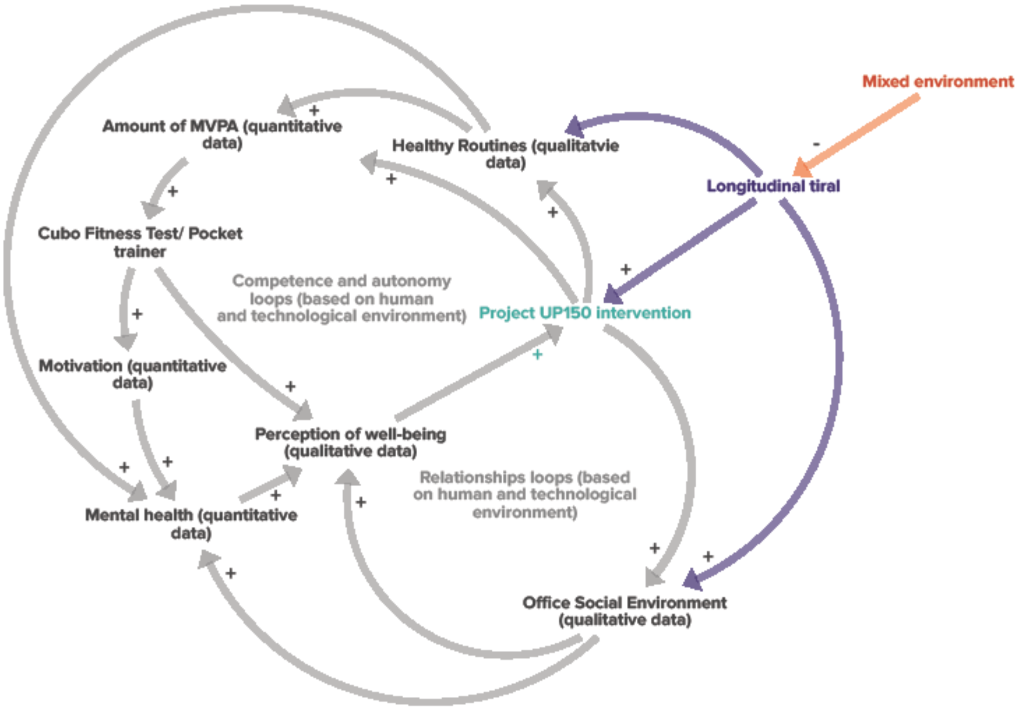

Figure 8. Interactions of variables of the mixed environment of the longitudinal study and the UP150 approach features (colored lines and words). Grey lines and words: results from the previous study on the UP150 approach. Continuous lines: interactions between variables (from measurements and semi-structured interviews). The positive or negative influence between variables is evidenced by symbols + and -. The green and red circles indicate the influence effects of the present study.

4.5. Limitations

Two limitations in this study may have affected the results: the number of participants and the need for more information on complementary factors such as workers' job performance and sickness absences. Even if the sample resulted adequately for this study design, it was considered insufficient for an explanatory statement of the gender-specific and age-specific impact of the UP150 concept. Concerning possible effects of the UP150 concept on employee job performance or reduction of days of absence (that are presumed to be possible favorable outputs of the intervention), privacy issues and company policies do not permit the collection of job-related personal information, which in future studies would complete the analysis of benefits for workers and employers.

5. Conclusion

The prolonged application of the UP150 procedure in a mixed working context for involvement in corporate policies, such as in the present longitudinal intervention, confirmed the preliminary result of the previous study, positively affects workers' physical, and psychological well-being. Moreover, present study brought new important insights highlighting the positive effect of the concept on clinical wellbeing (glucose, insulin, triglycerides, total cholesterol, and HDL). However, unlike the previous studies, more time to detect the effects is required (at least six months), possibly because the mixed environment consequences alter the UP150 routines of the workers involved as an experimental group. Within a broader vision, education for the movement, prolonged over time, is a leverage point for the whole system. On the contrary, a mixed environment with both people engaged and non-engaged in the UP150 concept, in a particular context such as that of the office, could be a point of resistance to changing approach and move during the workday, denoting how the evolution of the working culture must necessarily start from shared and encouraged company policies. Ultimately, the UP150 concept, thanks to technology closely assisted by the education in exercising as provided by wellness coaches through supportive communication, maintains its effects over time and is effective in building and consolidating virtuous routines for health.

General discussion

The studies highlighted the impact of the UP150 concept on different levels of desk workers' working reality. In particular, the investigations showed how an education-based healthy lifestyle promotion intervention must consider the complexity of the specific reality.

UP150's concept elements principal results' resume

The final considerations about the UP150 concept's elements are the following:

- The Cubo Fitness Test could represent a valid tool to evaluate a population of desk workers as in "analysis and exploration A and B" (*Steps 1 and 2*) and "design and construction A" (*Step 4*) investigated its validity and reliability. In particular, "analysis and exploration B" (*Step 2*) demonstrated that CFT characteristics make the measures valid even in mental fatigue conditions typical of prolonged conceptual tasks like desk-worker routines. Moreover, as highlighted in all studies, the main features that characterize CFT (a submaximal test based on perceived exertion) make the tool notably indicated to be performed in a particular environment, such as the office that does not allow gym outfit or sweat during working hours.
- The App UP150 and pocket trainer were efficient as tools to motivate employees to engage in and maintain an adequate level of physical activity not only during working hours but even outside the working context, as seen in "Design and Construction A and B" (*Steps 4 and 5*) and "Evaluation and reflection" (*Step 6*). This result is of particular relevance as in "analysis and exploration C" (*Study 3*), it is highlighted that companies are increasing the purpose of hybrid working modality; hence, the UP150 concept must also be addressed in this particular condition to support the employees appropriately. The App UP150 and the pocket trainer showed their efficacy in acute and longitudinal trials, helping to increase the weekly amount of physical activity. Moreover, the employees highlighted its usefulness in maintaining an adequate physical routine. Nevertheless, as shown in "Design and Construction B" (*Step 5*), the app itself could bring fewer results if not adequately introduced and motivated by wellness coaches, confirming the complexity of the motivation in the working environment (system thinking approach, see Figure 9).
- The wellness coaches resulted in a fondant element of the UP150 concept. As highlighted in "Design and Construction B" (*Step 5*), it resulted in the main element that can change working routines while motivating to maintain fair levels of physical activity and adapting the physical exercise to working and daily life necessities. As evidenced in "Analysis and Exploration C" (*Step 3*), workers can have different necessities depending on the workplace (remote, hybrid or on-site) and working hours. The "Design and Construction A and B" (*Steps 4 and 5*) and the "Evaluation and Reflection" (*Step 6*) showed how wellness coaches can be efficiently inserted in the workplace, improving employees' psychophysical wellness.
- The architectural changes developed appositely for the concept facilitated the approach to physical activity during working hours, as highlighted in "Design and Construction A and B" (*Steps 4 and 5*) and "Evaluation and Reflection" (*Step 6*). The possibility of physical activity during the usual workflow and active pauses during regular working pauses permitted reaching the suggested levels of physical activity.

From the studies conducted, it is possible to assess that the UP150 brought benefits to the desk-workers population investigated. As highlighted in the system thinking scheme of the "Evaluation and Reflection" (*Step 6*), worker wellness is a complex composition of elements' interaction, including physical, psychological, architectural, technological and organizational factors. To properly propose the concept in such a variable and complex context, it is necessary to use human sensibility

(wellness coaches), which can represent the bridge between the company, the employees, and the policies.
However, in a UP150 diffusion-oriented view, it is crucial to consider the broader implications of the project. We must carefully evaluate how the project can be socially and economically sustainable. The following paragraph will delve into this critical aspect.

Project sustainability in the working context

The present research needs to be contextualized in a broader economic and social frame. Indeed, to promote a culture based on physical literacy, physical education must renew itself by adapting its proposal to the reference reality (social utility).

In 2015, the United Nations (UN) scheduled a change program to be achieved by 2030, where several sustainable development goals were proposed.

Physical exercise models, such as quality physical education or health physical education, can help support the mentioned sustainable goals (Baena-Morales and González-Víllora 2023; UNESCO 2015). Indeed, these models allow the development of higher educative awareness, starting from modifying cultures and behaviors that are unfunctional to wellness and reducing/managing the negative impact of a technological and robotic society on the social environment.

The introduction of an adapted physical activity in the office's usual workflow (undertaken in this PhD project with the company 'Progetto CMR') through dedicated companies' policy is highly topical, and represents a pioneering use of physical activity targeted to achieve several sustainable development goals in which health is of particular relevance (United Nations 2015).

In this innovative reality, the sport science specialist become the key element for an intervention that require scientific and humanistic competences oriented to working professions (Challis 2021).

The concept of a "reverse evolution" in the use of technology (app and technological architectural changes oriented to reverse sedentary promotion dynamics; see figure 1 of “evaluation and reflection”) and awareness-based tools such as CFT and pocket trainer can become indispensable instruments for flexible intervention oriented to a lifetime decrease of sedentary behaviours, allowing a reduction of health costs, absenteeism, and productivity in companies (Budzynski-Seymour et al. 2021; Teotónio and Rose 2001)

In particular, the present work contributes to the "3 pillars model of sustainable development" (social, environmental and economic; Purvis, Mao, and Robinson 2019). The social dimension is represented by the promotion of health and wellness (UN sustainable development goal 3); the environmental dimension is represented by the spread of sustainable lifestyle (UN sustainable development goal 4); the economic dimension is represented by promoting occupational-specific competencies oriented to the development of decent working condition and new business ideas (UN sustainable development goal 4; Baena-Morales and González-Víllora 2023).

Hence, the introduction of a movement culture based on quality physical literacy in working contexts, with the modality proposed in the present paper, could promote work sustainability oriented to individual and collective well-being. The project can also better impact employees' and managers' awareness regarding its potential positive socio-environmental effect through more profound attention and care of human resources.

To pursue this direction, it is necessary to implement university programs with educative-methodological, scientific, professional, and social key competencies to promote physical activity sustainably in working contexts, allowing more opportunities for sports science graduates.

The results of the present study revealed how a well-designed physical activity could represent a powerful vehicle. It promotes the new idea of considering the company not only as a workplace but also as a care, developmental, and wellness place for employees.

General practical application.

Stepping back to the introduction's spaceship metaphor, in the present PhD thesis, the three main phases of testing (feasibility, simulation proof, and robustness) gave positive results. Following the considered studies, the company "Progetto CMR" that financed the research will represent the vehicle for the "market launch" of the UP150 concept, allowing the spread of this new working reality in different companies. The diffusion of the UP150 in different working environments could enhance the possibility of deepening this specific research field, increasing the knowledge about employee care and physical literacy in the working context.

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