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**ORIGINAL ARTICLE**

# COVID-19 lockdown: Physical activity, sedentary behaviour and sleep in Italian medicine students

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**Abstract**
COVID-19 pandemic led many countries to implement lockdown measures. Italy declared lockdown from 9th March to 3rd May 2020, and universities shifted to online classes. Home confinement could prevent students from achieving the physical activity and sleep levels recommended for their psychophysical health, and medicine students are already known to be at risk of inactivity and reduced sleep due to their time-consuming curricula. This study aimed at describing medicine students' behaviours during lockdown and comparing them with pre-lockdown data and current recommendations. A cross-sectional questionnaire survey was conducted among 6th-year Italian medicine students ($n = 714$; age=25 ± 2 y; female: 62%; male: 38%) in October–November 2019. The same survey was repeated in 6th-year students during lockdown ($n = 394$; age=25 ± 2 y; female: 73%; male: 27%), and extended to 1st–5th year (total 1st–6th-year sample during lockdown: $n = 1471$; age=23 ± 2 y; female: 70%; male: 30%). International Physical Activity Questionnaire Short Form (IPAQ) and selected questions from Pittsburgh Sleep Quality Index were administered to evaluate physical activity, sitting and sleep time. Decreased physical activity, and increased sitting and sleep time were observed from pre- to during lockdown in 6th-year students ($p<0.01$). 1st–6th-year students featured 10 [8–12] hours sitting (median [Q1–Q3]) and an IPAQ score of 1170 [400–2348] MET-min/week. Even participants with higher physical activity featured high sitting time. Sleeping less than recommended (<7 h/night) was associated with more sitting time and less energies to perform daily activities. Strategies fostering compliance with current guidelines for physical activity, sedentary behaviour and sleep should be implemented, especially in case of a repeated or intermittent lockdown.

**Keywords:** *Behaviour, health, lifestyle, sedentary living, youth*

**Highlights**
- During lockdown, medicine students reduced their total physical activity and increased sedentary behaviour.
- Walking time was reduced in favour of increased higher-intensity physical activity. However, total metabolic expenditure was lower than before lockdown.
- Before lockdown students slept less than the recommended 7 hours per night, but they increased sleep time during lockdown.
- Medical schools should promote education on physical activity and sleep, since it improves the health of students, doctors and patients. This is especially valuable in case of repeated lockdown.

## 1. Introduction

Coronavirus Disease 19 (COVID-19) pandemic, caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), emerged in December 2019 and is currently a major global health issue. This led many governments to establish strong measures to control the spread of the virus. Stringency of such measures varies among countries, ranging from increased surveillance and focused interventions to strict lockdown (Gibney, 2020). Stricter measures limit unessential interactions, movement and working activities to pursue more control in disease transmission, at cost of increasing

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risk factors for non-communicable diseases (Lee et al., 2012).

In this context, achieving recommended levels of physical activity is crucial to achieve the physiologic and psychosocial benefits associated with physical activity, and reduce the risk of several chronic diseases (Blair, 2009; Chen et al., 2020; Fiuza-Luces, Garatachea, Berger, & Lucia, 2013; Narici et al., 2020). Moreover, physical activity can attenuate the detrimental effects of sedentary behaviour and its association with all-cause mortality (Ekelund et al., 2016). Current guidelines by World Health Organization (WHO) and American College of Sports Medicine (ACSM) recommend performing at least 150 min of moderate-intensity (or 75 min of vigorous-intensity) aerobic physical activity per week, together with muscle-strengthening activities two or more days per week. Limiting sedentary behaviour throughout the day is also recommended (Global Recommendations on Physical Activity for Health, 2010; U.S. Department of Health and Human Services, 2018). Furthermore, attention should be given to sleep behaviours both for reciprocal influences with physical activity (Chennaoui, Arnal, Sauvet, & Léger, 2015) and, more in general, for psychophysical health (Watson et al., 2015). Aerobic physical activity can improve sleep time through its effects on metabolic, endocrine, vascular and immune systems, on mood and circadian rhythm. On the other hand, both chronic and acute sleep loss can reduce physical performance, alertness and rates of perceived exertion during physical activity (Chennaoui et al., 2015). According to current recommendations by American Academy of Sleep Medicine (AASM) and Sleep Research Society (SRS), adults aged 18–60 years should sleep at least 7 h per night (Watson et al., 2015).

On 9th March 2020, Italy declared a strict nationwide quarantine. In particular, universities shifted to online classes, leading students to attend lessons and take exams from their home. University students are already known to be a population at risk for high levels of sedentary behaviour (Castro, Bennie, Vergeer, Bosselut, & Biddle, 2020), and this extraordinary situation could put them at even greater risk. Among them, medicine students are particularly prone to unhealthy lifestyles due to their time-consuming curricula (Mandic et al., 2020). The first years of medical school are dedicated to basic science and pose particularly stressful academic demands, while clinical rotations are a major source of demand for students in their last years (Lee & Graham, 2001). The rationale for assessing healthy lifestyles among students comes from two considerations. On one side, students need to improve or maintain their personal health. On the other side, students who know and adopt healthy lifestyles will be, as future physicians, better promoters of healthy behaviours for their patients (Almohaya et al., 2013; Chew, Ho, Kee, & Sirisena, 2019; Frank, Elon, & Hertzberg, 2007; Strong et al., 2017). It is unclear how lockdown affected physical activity, sedentary behaviour and sleep among medicine students and how to intervene to revert possible detrimental effects.

In this light, the aims of this study were: (i) to describe physical activity, sedentary behaviour and sleep of Italian medicine students during COVID-19 lockdown and (ii) to compare them with data collected prior to lockdown (October–November 2019) and with current recommendations, in order to identify detrimental and positive lifestyle changes and study possible interventions.

## 2. Materials and methods

### 2.1. Study design and sample

A repeated cross-sectional online questionnaire survey (Lavrakas, 2008) was conducted among students enrolled in Italian medical schools, who were invited to participate through their student representatives. Data about demographics, physical activity, sedentary behaviour and sleeping habits were collected.

Students attending the 6th year were invited to fill in the questionnaire from 6th October 2019 to 27th November 2019 as the first part of a repeated cross-sectional study on their physical activity, sedentary behaviour and sleep. Inclusion criteria were (i) being enrolled in an Italian medical school and (ii) attending the 6th year of medical school. There were no exclusion criteria. The convenience sample was recruited by contacting the student representatives of each class, who invited all the students in their class to fill in the online questionnaire.

During the period of strict Italian lockdown, from 9th March 2020 to 3rd May 2020, students attending 1st to 6th year were invited to fill in the same questionnaire. Inclusion criteria were (i) being enrolled in an Italian medical school and (ii) attending 1st to 6th year of medical school. There were no exclusion criteria. The same sampling strategy was adopted. The availability of data from 6th year before and during lockdown, with the same measurement instrument, made suitable the comparisons between similar subsamples. Data on 1st–5th year students were used to extend results and assess potential year-related differences. The study flowchart is illustrated in Figure 1 and the completed STROBE checklist is attached as a supplementary material (von Elm et al., 2007).

### 2.2. Measurement instrument

Physical activity was evaluated using the International Physical Activity Questionnaire Short Form (IPAQ-

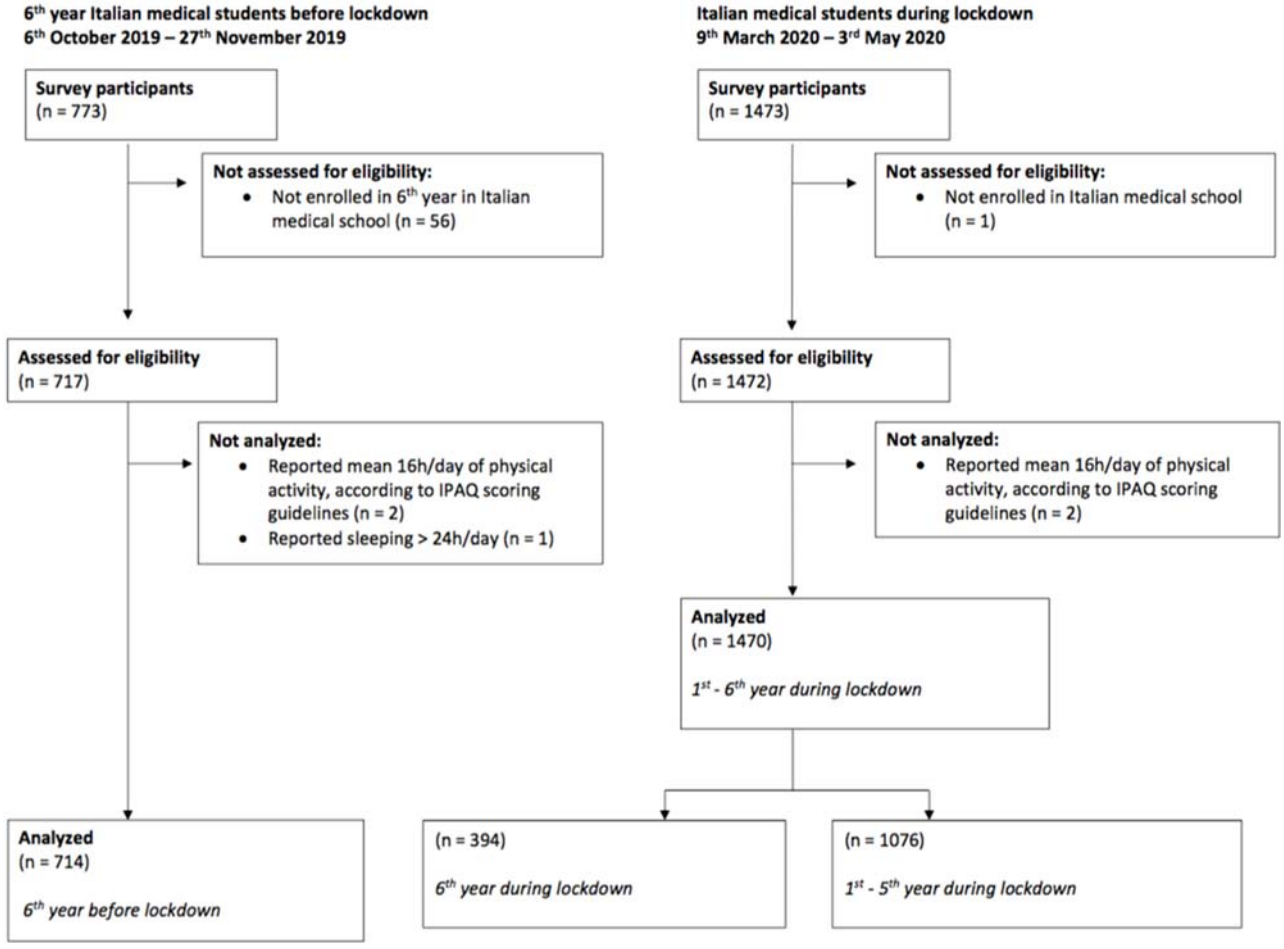


Figure 1. Flowchart of the study.

SF), whose reliability and validity are documented (Craig et al., 2003; Lee, Macfarlane, Lam, & Stewart, 2011). The questionnaire referred to the last 7 days and asked about walking, moderate-intensity activities, vigorous-intensity activities and sitting time. Additionally, a set of ad hoc questions asked participants to self-assess variations of physical activity during lockdown (Supplementary material, Table S1). Sleep and rest were evaluated by means of selected questions from Pittsburgh Sleeping Quality Index Questionnaire (PSQI) (Buysse, Grunstein, Horne, & Lavie, 2010; Curcio et al., 2013; Mollayeva et al., 2016) and referred to the last 7 days (Supplementary material, Table S1).

### 2.3. *Data analysis and statistics*

Data from IPAQ-SF questionnaire were analysed according to IPAQ scoring guidelines (Guidelines for Data Processing and Analysis of the International Physical Activity Questionnaire (IPAQ), 2005). Physical activity was estimated by multiplying the MET score of each activity by the total amount of minutes spent per week. It was reported as a continuous measure and expressed as metabolic equivalent minutes per week (MET-min/week). Sitting time was assessed by the specific IPAQ-SF question and expressed in hours per day.

Descriptive statistics were calculated for each sample and for subsamples during lockdown, as shown in Table I. As suggested by IPAQ scoring guidelines (Guidelines for Data Processing and Analysis of the International Physical Activity Questionnaire (IPAQ), 2005) and due to their skewness, both physical activity and sitting time were presented as median and interquartile range. Additionally, the 1471 students of the whole lockdown sample were classified into mutually exclusive categories by combining their activity patterns ('high sitting' or 'low sitting', 'high active ' or 'low active'). For this purpose, thresholds for physical activity and sitting time were based on the previous meta-analysis by Ekelund et al. (2016). Participants were defined as 'high active' if totalising more than 16 MET-hours per week (960 MET-min/week), based on median

Table I. Sample characteristics, physical activity, sitting time and sleep behaviours.

| | Pre-lockdown | Lockdown | | |
|---|---|---|---|---|
| | 6th year ($n = 714$) Mean ± SD | 6th year ($n = 394$) Mean ± SD | 1st–5th year ($n = 1077$) Mean ± SD | 1st–6th year ($n = 1471$) Mean ± SD |
| Age (years) | 25 ± 2 | 25 ± 2 | 22 ± 2 | 23 ± 2 |
| Gender | % | % | % | % |
| Female | 62 | 73 | 68 | 70 |
| Male | 38 | 27 | 32 | 30 |
| Other | <1 | <1 | <1 | <1 |
| Physical activity | Median [Q1–Q3][a] | Median [Q1–Q3] | Median [Q1–Q3] | Median [Q1–Q3] |
| IPAQ score (MET-min/week) | 1588 [809–2895]* | 960 [396–1524]* | 1200 [438–2400] | 1170 [400–2348] |
| Walk (MET-min/week) | 693 [359–1386]* | 99 [0–347]* | 66 [0–334] | 66 [0–347] |
| Moderate (MET-min/week) | 0 [0–240]* | 80 [0–400]* | 120 [0–480] | 120 [0–420] |
| Vigorous (MET-min/week) | 360 [0–1440] | 480 [0–1440] | 640 [0–1600] | 640 [0–1600] |
| Walk time (min/week) | 210 [109–420]* | 30 [0–105]* | 20 [0–101] | 20 [0–105] |
| Moderate time (min/week) | 0 [0–60]* | 20 [0–100]* | 30 [0–120] | 30 [0–105] |
| Vigorous time (min/week) | 45 [0–180] | 60 [0–180] | 80 [0–200] | 80 [0–200] |
| | %[b] | % | % | % |
| Walk time | 67 | 34 | 29 | 30 |
| Moderate time | 10 | 26 | 26 | 26 |
| Vigorous time | 23 | 40 | 45 | 44 |
| Sedentary behaviour | Median [Q1–Q3] | Median [Q1–Q3] | Median [Q1–Q3] | Median [Q1–Q3] |
| Sitting time per day (hours) | 8 [6–10]* | 10 [8–12]* | 10 [8–12] | 10 [8–12] |
| Sleep | Mean ± SD | Mean ± SD | Mean ± SD | Mean ± SD |
| Sleep hours per night (hours) | 6.7 ± 0.9** | 7.4 ± 1.1** | 7.6 ± 1.0 | 7.5 ± 1.1 |

[a]Q1: 1st quartile. Q3: 3rd quartile.
[b]Mean percentage of time spent on a specific domain, over total physical activity time.
*$p < 0.01$; Mann–Whitney test.
**$p < 0.01$; unpaired $t$-test.

split by Ekelund et al. (2016), and 'high sitting' if sitting more than 6 h per day (Table II).

Mann–Whitney test was used to compare IPAQ physical activity score and sitting time in 6th-year students before and during lockdown. Unpaired $t$-test was used to test the difference between means for sleep time. A test for difference in proportions was used for categorical variables. All data and statistical analyses were performed using R and R studio.

## 3. Results

773 students completed the pre-lockdown survey from 6th October 2019 to 27th November 2019.

Table II. Activity behaviours.

| | Low physical activity Physical activity < 16 MET-hours/week (960 MET-min/week)[a] | High physical activity Physical activity ≥ 16 MET-hours/week (960 MET-min/week)[a] |
|---|---|---|
| High sitting time | High sitting–low active | High sitting–high active |
| Sitting time ≥ 6 h/day[b] | 40% | 52% |
| Low sitting time | Low sitting–low active | Low sitting–high active |
| Sitting time < 6 h/day[c] | 3% | 5% |

Notes: Frequency of mutually exclusive behaviours is shown as a percentage of all the occurrences. Cutoffs for physical activity and sitting time are based on previous literature (Ekelund et al., 2016).
[a]Median split by Ekelund et al. (2016).
[b]Threshold for lowest sitting time groups in Ekelund et al. (2016).
[c]Threshold for highest sitting time groups in Ekelund et al. (2016).

Among them, 56 were not included because they did not meet the inclusion criteria; three surveys were not analysed because they reported invalid variables or according to IPAQ guidelines for data processing and analysis (Guidelines for Data Processing and Analysis of the International Physical Activity Questionnaire (IPAQ), 2005). This led to 714 participants for 6th year, pre-lockdown sample (Figure 1). Participants (62% females; 38% males; <1% other gender) had an average age of 25 ± 2 years (see Table I for sample characteristics). There were no missing data. 1473 students completed the survey during lockdown from 9th March 2020 to 3rd May 2020. Among them, one was not included due to not meeting the inclusion criteria; two surveys were not analysed because they reported invalid variables or according to IPAQ guidelines for data processing and analysis (Guidelines for Data Processing and Analysis of the International Physical Activity Questionnaire (IPAQ), 2005). This led to 1470 participants for 1st–6th year, lockdown sample (Figure 1). Participants (70% females; 30% males; <1% other gender) had an average age of 23 ± 2 years (see Table I for sample characteristics). There were no missing data.

### 3.1. *Physical activity and sedentary behaviour*

IPAQ score expressed as metabolic equivalent minutes per week (MET-min/week) was used as a general indicator of physical activity. We found a median IPAQ score of 1588 MET-min/week in 6th-year students before lockdown and 960 MET-min/week in 6th-year students during lockdown, with a reduction of 628 MET-min/week ($p < 0.01$) (Table I). Time elapsed on each IPAQ domain-specific activity (walking, moderate and vigorous) was plotted in Figure 2 and reported as minutes per week and percentage of total activity time in Table I. This showed a prevalence of moderate-vigorous activity over walking during lockdown. In 6th-year students, time dedicated to moderate and vigorous activity increased during lockdown ($p < 0.01$ for moderate physical activity, $p = 0.30$ for vigorous physical activity), while walking time decreased ($p < 0.01$). Furthermore, an increase in sedentary behaviour was observed: 6th-year students spent a median of 8 h/day sitting before lockdown, and 10 h/day during lockdown ($p < 0.01$) (Table I).

Students from 1st to 5th year during lockdown featured similar levels of physical activity, sedentary behaviour and sleep to those reported for the 6th-year subsample during lockdown (Table I). Hence, the full sample of medicine students (1st–6th year) in home confinement featured an overall median IPAQ score of 1170 [400–2348] MET-min/week (median [1st quartile–3rd quartile]) and 10 [8–12] hours sitting/day (median [1st quartile–3rd quartile]) (Table I). Students spent more time on moderate-vigorous activity over walking during lockdown (Figure 2 and Table I). However, the majority of students reported a reduction in total physical activity due to less walking and movements (65%), impossibility to access sports facilities or lack of gym equipment (51%), and less time for physical activity (9%) (answers were not mutually exclusive). On the other hand, 27% of students reported increased physical activity due to having more time or energy to dedicate and 16% reported unmodified levels of physical activity with modified modalities. Over 90% of students (1st–6th year during lockdown) spent more than 6 h/day sitting, and the majority (52%) were 'high sitting–high active' (defined as sitting more than 6 h/day and featuring more than 16 MET-hours/week of physical activity) (Table II).

### 3.2. *Physical activity and sleep*

Among 6th-year students, there was an increase in sleep time as they were sleeping 6.7 ± 0.9 h/night before lockdown and 7.4 ± 1.1 during lockdown ($p < 0.01$). Specifically, 37% slept less than 7 h per night before lockdown, and 20% during lockdown. Notably, 7 h is the minimum recommended for their age by current guidelines (Watson et al., 2015).

Reported sleep time in 1st–6th year during lockdown was 7.5 ± 1.1 h per night (Table I), with 16% sleeping less than 7 h per night. Hours sitting per day was higher among students who were sleeping less than 7 h per night (10.3 vs 9.6; $p < 0.01$). 50% of students sleeping less than 7 h per night reported insufficient energy to perform their daily activities, compared with 31% among students sleeping more than 7 h per night ($p < 0.01$).

## 4. Discussion

We observed a decrease in total physical activity and an increase in sitting time from pre- to during lockdown among 6th-year students. By classifying 1st–6th-year students during lockdown into mutually exclusive behaviours we found that even physically active students were mainly 'high sitting–high active'. Sitting time was on average 10 h per day, and higher among those sleeping less than 7 h per night.

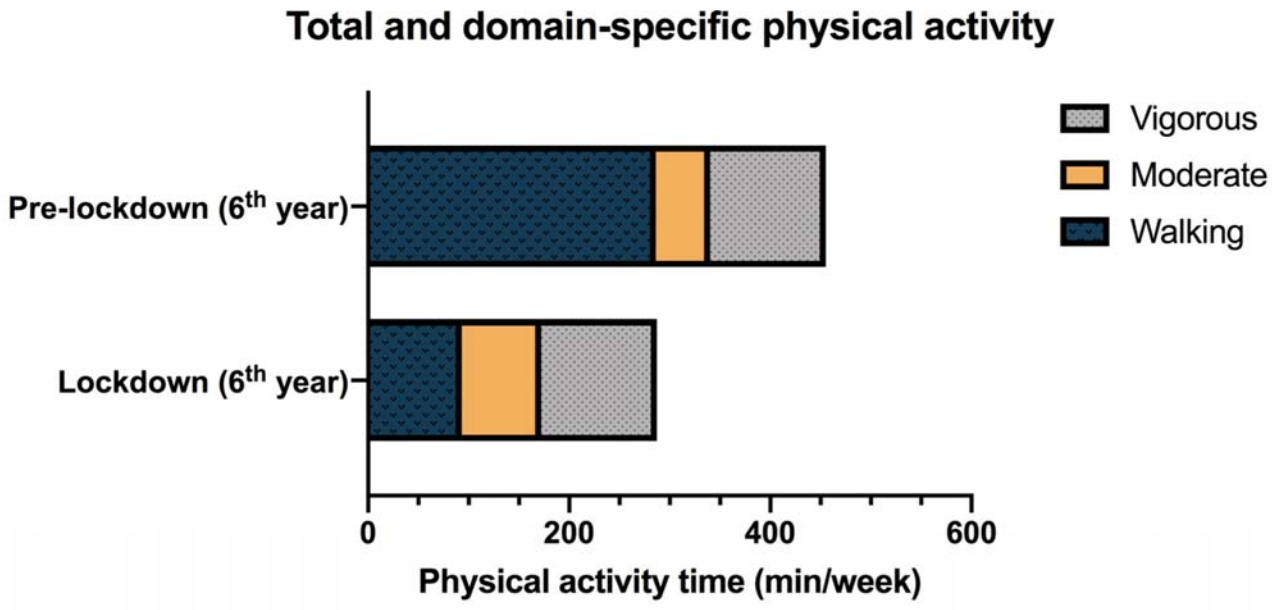


Figure 2. Total and domain-specific physical activity. Total and domain-specific physical activity time (reported as minutes of activity per week). Pre-lockdown group (6th-year students) and lockdown group (only 6th-year students) are shown. Mean physical activity is expressed as minutes per week (min/week).

### *4.1. Physical activity and sedentary behaviour*

It has previously been suggested that COVID-19 quarantine measures could have reduced structured and unstructured physical activity (Chen et al., 2020; Narici et al., 2020). Medicine students are at risk for high sedentary behaviour and low physical activity levels (Castro et al., 2020). In Italy, during lockdown, universities shifted to online classes; therefore, students did not have to move to (and from) university or attend clinical rotations, which could have additionally reduced their physical activity and increased their sedentary behaviour. Our data on 6th-year students suggest a relevant reduction of physical activity (median decrease of 600 MET-min/week) and an increase in sitting time (about 2 h/day) during lockdown compared with pre-lockdown (Table I); moreover, a shift in physical activity domains was observed. Walking was a major source of physical activity in students before lockdown. Due to the strict confinement measures of March–May 2020, walking time was reduced in favour of an increase in higher-intensity physical activity, which could have been performed at home as circuit training (Figure 2, Table I). However, total physical activity MET-minutes were reduced, therefore the increase in moderate and vigorous activity did not counterbalance the reduced walking time.

Pre-lockdown data were not available for students attending 1st–5th year of medical school, but extending the study on these students during lockdown allowed for further analysis on their behaviours and helped generalising our findings. The 1st–5th year sample during lockdown showed similar levels of physical activity and sedentary behaviour as described for the 6th year during lockdown. Self-reported variations in physical activity were assessed, and 65% of 1st–6th-year students reported a decrement due to less walking, as a result of the Italian confinement restrictions. The introduction of less strict measures may revert this trend and promote walking and unstructured physical activity.

Since previous studies pointed out the detrimental effects of both sedentary behaviour and physical inactivity on physical and psychological health (Allen, Walter, & Swann, 2019; Ekelund et al., 2016), students of the whole lockdown sample were classified by combining their activity patterns (Table II). Over 90% of students spent more than 6 h/day sitting, largely more than previous evidence on university students (about 50% (Castro et al., 2020)). Even participants with high levels of physical activity (more than 16 MET-hours/week) were mainly 'high sitting–high active' (Table II).

Previous epidemiological evidence showed that high levels of physical activity and exercise may attenuate the detrimental effects of sedentary behaviour (Ekelund et al., 2016; Narici et al., 2020). However, the amount of physical activity required to eliminate the adverse effects of prolonged sitting time was higher than 30 MET-hours/week. Lower levels of activity did only mitigate these effects, and this could be the rationale for interventions aimed at reducing sitting time also in high active students

(>16 MET-hours/week). Following current recommendations for physical activity (Global Recommendations on Physical Activity for Health, 2010; U.S. Department of Health and Human Services, 2018) may be a good lifestyle modification for 'low active' participants (43% of observed sample); at the same time, less time sitting (e.g. standing while watching online lessons or walking while making phone calls) would be highly beneficial for over 90% of considered students (Stamatakis et al., 2019) (Table II). These data confirm the important role of regular exercise at home and reduction of sedentary behaviour during COVID-19 crisis (Chen et al., 2020; Narici et al., 2020).

### 4.2. *Physical activity and sleep*

Previous evidence points out a relevant influence of COVID-19 lockdown on sleep behaviours (Altena et al., 2020). An increase in sleep time may be noticed in some individuals due to a lack of strict onset hours and the possibility to tailor schedules to personal needs (Cellini, Canale, Mioni, & Costa, 2020). Sleep habits could also have changed due to the reciprocal influence between sleep and exercise (Arbinaga, Fernández-Cuenca, Fernández-Ozcorta, Toscano-Hermoso, & Joaquin-Mingorance, 2019; Chennaoui et al., 2015). Our results showed an increase in mean sleep time during the lockdown period, similar to other recent studies on the impact of COVID-19 pandemic on students (Romero-Blanco et al., 2020; Wright et al., 2020) and general population (Advani et al., 2020). Among many possible factors contributing to an increase in sleep time, some can be specifically referred to this target population. Important changes in the medicine students' daily routine concern three main facts: lessons were online, clinical rotations did not take place, and the time spent to get to and from university and/or hospitals reduced to zero. This may have allowed more flexible schedules and more time for sleep (Wright et al., 2020). Sleeping at least 7 h per night is recommended by current guidelines for adults aged 18–60 years (Watson et al., 2015); in the present study, 37% of 6th-year students slept less than 7 h before lockdown and 20% during lockdown. This improvement may be beneficial for medicine students' health and would be essential to maintain it post-lockdown (Watson et al., 2015). As for physical activity and sitting time, extending the analysis to 1st–5th-year students during lockdown showed similar results to those of 6th year.

Interestingly, students not meeting these recommendations featured higher sitting time and less (self-reported) energy to perform daily activities, although a causal association cannot be inferred. Sleep hygiene education may help improving both sleep behaviours and physical activity, in particular for students with poorer sleep habits (Arbinaga et al., 2019).

### 4.3. *Implications for medicine students and medical schools*

Improving physical activity and sleep and reducing sedentary behaviour would be beneficial for the health of many medicine students. Understanding the importance of lifestyle interventions may also be beneficial for their future physician-patient relationship. Hence, strategies fostering compliance with current guidelines (Global Recommendations on Physical Activity for Health, 2010; U.S. Department of Health and Human Services, 2018; Watson et al., 2015) should be taught and implemented. This could be especially valuable in the possible scenario of new future quarantines, since intermittent social distancing may be required in case of increased wintertime transmissibility of COVID-19 (Kissler, Tedijanto, Goldstein, Grad, & Lipsitch, 2020).

As young adults, students should perform at least 150 min of moderate-intensity (or 75 min of vigorous-intensity) aerobic physical activity per week, and muscle-strengthening activities two or more days per week (Global Recommendations on Physical Activity for Health, 2010; U.S. Department of Health and Human Services, 2018). Universities could inform and educate students on these guidelines, help them allocate time to physical activity, provide proper facilities and illustrate the possibilities for home workout in case of a new lockdown or confinement (Mandic et al., 2020). When possible, students should engage in active transport (e.g. walking or biking to university) (U.S. Department of Health and Human Services, 2018). In case of home confinement, they could frequently interrupt sitting time with bouts of walking (e.g. during phone calls) or study in a standing position in order to limit prolonged sedentary behaviour (Benatti et al., 2017; Benatti & Ried-Larsen, 2015; Narici et al., 2020; Pulsford, Blackwell, Hillsdon, & Kos, 2017). Information and education on current sleep recommendations and sleep hygiene could also be appropriate (Stepanski & Wyatt, 2003; Watson et al., 2015). Students should maintain a regular sleep schedule and wake-up time in the morning, reduce the use of light-emitting screens before bedtime and consumption of caffeine, alcohol and nicotine (Spadola et al., 2019; Stepanski & Wyatt, 2003). Their bedroom environment may be adjusted to decrease stimuli. Sleep may also benefit from the aforementioned recommendations on regular exercise

(Hartescu, Morgan, & Stevinson, 2015; Stepanski & Wyatt, 2003). Mean sleep time increased during lockdown (Advani et al., 2020; Romero-Blanco et al., 2020; Wright et al., 2020), and maintaining flexible and less overloaded schedules may help to preserve this improvement after the pandemic.

Of note, medical school programmes currently provide limited education on physical activity and sleep. This is mainly due to lack of dedicated time and qualified staff, and an overall perception of such education as low priority (Almohaya et al., 2013; Mindell et al., 2011; Strong et al., 2017). As a result, students consider their preparation as inadequate and perceive they have limited ability to deliver health behaviour change interventions (Chew et al., 2019). Improvements could be achieved by identifying competencies and goals and acting on the aforementioned barriers to their implementation (Mindell et al., 2011; Strong et al., 2017). Education on physical activity and sleep should be integrated across all components of the medical education programme, from basic physiology to clinical aspects and impact on disease and patient management (Strong et al., 2017). This would have an impact on medicine students and doctors' health and improve their role as facilitators and providers of interventions on physical activity, sedentary behaviour and sleep (Chew et al., 2019; Strong et al., 2017).

### 4.4. *Limitations and future perspectives*

This study comes with limitations. Self-reported physical activity, sedentary behaviour and sleep are less reliable than device-based measures, and may have led to under- or overestimation of these parameters (Lauderdale, Knutson, Yan, Liu, & Rathouz, 2008; Lee et al., 2011; Prince et al., 2020). Breaking up sedentary time may have positive effects on metabolic outcomes (Benatti et al., 2017; Benatti & Ried-Larsen, 2015; Pulsford et al., 2017), but IPAQ questionnaire does not distinguish prolonged from intermittent sedentary time.

The use of a convenience sample could have led to selection bias; furthermore, a control group was only available for 6th-year students. Outcome variables were compared between 6th-year students before (October to November 2019) and during lockdown (March to May 2020). In both periods Italian medicine students are out of their exam sessions (which are held from January to February, and from June to September), which allowed a comparison in similar conditions of university commitment, but being in different semesters can have influenced their lifestyle independently from COVID-19 lockdown (Rustagi, Taneja, Mishra, & Ingle, 2011). Therefore, we cannot conclude that observed differences are due to lockdown only.

Finally, repeating the survey in the post-lockdown period may give insights on the resumption of structured and unstructured physical activity and on long-term effects on physical activity, sedentary behaviour and sleep behaviours.

## 5. Conclusions

Medicine students are prone to sedentary behaviour and low levels of physical activity; COVID-19 crisis and subsequent confinement measures may be worsening this trend. Our data suggest that improving physical activity would be beneficial for many medicine students, and the vast majority would benefit from spending less time sitting in their daily routine. Strategies fostering compliance with current guidelines for physical activity, sedentary behaviour and sleep should be implemented; this may be especially valuable in case of repeated and intermittent lockdown and confinement measures.

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FL participated in the design of the study, contributed to data collection and data analysis. VC participated in the design of the study, contributed to data collection and data analysis. VV participated in the design of the study, contributed to data collection. GP participated in the design of the study, contributed to data analysis. All authors contributed to the manuscript writing. All authors have read and approved the final version of the manuscript, and agree with the order of presentation of the authors.

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### *Supplemental data*

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## References

Advani, I., Gunge, D., Banks, S., Mehta, S., Park, K., & Patel, M. (2020). Is increased sleep responsible for reductions in myocardial infarction during the COVID-19 pandemic? *American Journal of Cardiology*, *131*, 128–130.

Allen, M. S., Walter, E. E., & Swann, C. (2019). Sedentary behaviour and risk of anxiety: A systematic review and meta-analysis. *Journal of Affective Disorders*, *242*, 5–13.

Almohaya, A., Qrmli, A., Almagal, N., Alamri, K., Bahammam, S., Al-Enizi, M., et al. (2013). Sleep medicine education and knowledge among medical students in selected Saudi medical schools. *BMC Medical Education*, *13*, 133.

Altena, E., Baglioni, C., Espie, C. A., Ellis, J., Gavriloff, D., Holzinger, B., et al. (2020). Dealing with sleep problems during home confinement due to the COVID-19 outbreak: Practical recommendations from a task force of the European CBT-I Academy. *Journal of Sleep Research*, e13052.

Arbinaga, F., Fernández-Cuenca, S., Fernández-Ozcorta, E. J., Toscano-Hermoso, M. D., & Joaquin-Mingorance, M. (2019). Level of physical activity and sleep characteristics in university students. *Sleep Science (Sao Paulo, Brazil)*, *12*, 265–271.

Benatti, F. B., Larsen, S. A., Kofoed, K., Nielsen, S. T., Harder-Lauridsen, N. M., Lyngbæk, M. P., et al. (2017). Intermittent standing but not a moderate exercise bout reduces postprandial glycemia. *Medicine & Science in Sports & Exercise*, *49*, 2305–2314.

Benatti, F. B., & Ried-Larsen, M. (2015). The effects of breaking up prolonged sitting time: A review of experimental studies. *Medicine & Science in Sports & Exercise*, *47*, 2053–2061.

Blair, S. N. (2009). Physical inactivity: The biggest public health problem of the twenty-first century. *British Journal of Sports Medicine*, *43*, 1–2

Buysse, D. J., Grunstein, R., Horne, J., & Lavie, P. (2010). Can an improvement in sleep positively impact on health? *Sleep Medicine Reviews*, *14*, 405–410.

Castro, O., Bennie, J., Vergeer, I., Bosselut, G., & Biddle, S. J. H. (2020). How sedentary are university students? A systematic review and meta-analysis. *Prevention Science*, *21*, 332–343.

Cellini, N., Canale, N., Mioni, G., & Costa, S. (2020). Changes in sleep pattern, sense of time and digital media use during COVID-19 lockdown in Italy. *Journal of Sleep Research*, e13074.

Chen, P., Mao, L., Nassis, G. P., Harmer, P., Ainsworth, B. E., & Li, F. (2020). Coronavirus disease (COVID-19): The need to maintain regular physical activity while taking precautions. *Journal of Sport and Health Science*, *9*, 103–104.

Chennaoui, M., Arnal, P. J., Sauvet, F., & Léger, D. (2015). Sleep and exercise: A reciprocal issue? *Sleep Medicine Reviews*, *20*, 59–72.

Chew, E. J. C., Ho, Y. N., Kee, G. J., & Sirisena, D. (2019). Scoping review and international multi-centre cohort study investigating teaching, knowledge and beliefs regarding physical activity as a health intervention among medical students: A comparison between Singapore and the UK. *Singapore Medical Journal*, *60*, 642–651.

Craig, C. L., Marshall, A. L., Sjöström, M., Bauman, A. E., Booth, M. L., Ainsworth, B. E., et al. (2003). International physical activity questionnaire: 12-country reliability and validity. *Medicine & Science in Sports & Exercise*, *35*, 1381–1395.

Curcio, G., Tempesta, D., Scarlata, S., Marzano, C., Moroni, F., Rossini, P. M., et al. (2013). Validity of the Italian version of the Pittsburgh sleep Quality Index (PSQI). *Neurological Sciences*, *34*, 511–519.

Ekelund, U., Steene-Johannessen, J., Brown, W. J., Fagerland, M. W., Owen, N., Powell, K. E., et al. (2016). Does physical activity attenuate, or even eliminate, the detrimental association of sitting time with mortality? A harmonised meta-analysis of data from more than 1 million men and women. *The Lancet*, *388*, 1302–1310.

Fiuza-Luces, C., Garatachea, N., Berger, N. A., & Lucia, A. (2013). Exercise is the real polypill. *Physiology (Bethesda)*, *28*, 330–358.

Frank, E., Elon, L., & Hertzberg, V. (2007). A quantitative assessment of a 4-year intervention that improved patient counseling through improving medical student health. *MedGenMed*, *9*, 58.

Gibney, E. (2020). Coronavirus lockdowns have changed the way Earth moves. *Nature*, *580*, 176–177.

Global Recommendations on Physical Activity for Health. (2010). Geneva: World Health Organization [cited 2020 May 9]. (WHO Guidelines Approved by the Guidelines Review Committee).

Guidelines for Data Processing and Analysis of the International Physical Activity Questionnaire (IPAQ). (2005). Retrieved July 18, 2020, from https://www.ipaq.ki.se.

Hartescu, I., Morgan, K., & Stevinson, C. D. (2015). Increased physical activity improves sleep and mood outcomes in inactive people with insomnia: A randomized controlled trial. *Journal of Sleep Research*, *24*, 526–534.

Kissler, S. M., Tedijanto, C., Goldstein, E., Grad, Y. H., & Lipsitch, M. (2020). Projecting the transmission dynamics of SARS-CoV-2 through the postpandemic period. *Science*, *368* (6493), 860–868.

Lauderdale, D. S., Knutson, K. L., Yan, L. L., Liu, K., & Rathouz, P. J. (2008). Sleep duration: How well do self-reports reflect objective measures? The CARDIA sleep study. *Epidemiology*, *19*, 838–845.

Lavrakas, P. J. (2008). *Encyclopedia of survey research methods*. Thousand Oaks.: SAGE Publications. Repeated cross-sectional design, pp. 714–716.

Lee, J., & Graham, A. V. (2001). Students' perception of medical school stress and their evaluation of a wellness elective. *Medical Education*, *35*, 652–659.

Lee, P. H., Macfarlane, D. J., Lam, T., & Stewart, S. M. (2011). Validity of the international physical activity questionnaire short form (IPAQ-SF): A systematic review. *International Journal of Behavioral Nutrition and Physical Activity*, *8*, 115.

Lee, I.-M., Shiroma, E. J., Lobelo, F., Puska, P., Blair, S. N., & Katzmarzyk, P. T. (2012). Impact of physical inactivity on the World's major non-communicable diseases. *Lancet*, *380*, 219–229.

Mandic, D., Bjegovic-Mikanovic, V., Vukovic, D., Djikanovic, B., Stamenkovic, Z., & Lalic, N. M. (2020). Successful promotion of physical activity among students of medicine through motivational interview and Web-based intervention. *PeerJ*, *8*.

Mindell, J. A., Bartle, A., Wahab, N. A., Ahn, Y., Ramamurthy, M. B., Huong, H. T. D., et al. (2011). Sleep education in medical school curriculum: A glimpse across countries. *Sleep Medicine*, *12*, 928–931.

Mollayeva, T., Thurairajah, P., Burton, K., Mollayeva, S., Shapiro, C. M., & Colantonio, A. (2016). The Pittsburgh sleep quality index as a screening tool for sleep dysfunction in clinical and non-clinical samples: A systematic review and meta-analysis. *Sleep Medicine Reviews*, *25*, 52–73.

Narici, M., De Vito, G., Franchi, M., Paoli, A., Moro, T., Marcolin, G., et al. (2020). Impact of sedentarism due to the COVID-19 home confinement on neuromuscular, cardiovascular and metabolic health: Physiological and pathophysiological implications and recommendations for physical and nutritional countermeasures. *European Journal of Sport Science*, 1–22.

Prince, S. A., Cardilli, L., Reed, J. L., Saunders, T. J., Kite, C., & Douillette, K. (2020). A comparison of self-reported and device measured sedentary behaviour in adults: A systematic review and meta-analysis. *The international Journal of Behavioral Nutrition and Physical Activity*, *17*, 31.

Pulsford, R. M., Blackwell, J., Hillsdon, M., & Kos, K. (2017). Intermittent walking, but not standing, improves postprandial insulin and glucose relative to sustained sitting: A randomised cross-over study in inactive middle-aged men. *Journal of Science and Medicine in Sport*, *20*, 278–283.

Romero-Blanco, C., Rodríguez-Almagro, J., Onieva-Zafra, M. D., Parra-Fernández, M. L., del Carmen Prado-Laguna, M., & Hernández-Martínez, A. (2020). Sleep Pattern changes in Nursing students during the COVID-19 lockdown. *International Journal of Environmental Research and Public Health*, *17*, 5222.

Rustagi, N., Taneja, D., Mishra, P., & Ingle, G. (2011). Cardiovascular risk behavior among students of a medical College in Delhi. *Indian Journal of Community Medicine*, *36*, 51–53.

Spadola, C. E., Guo, N., Johnson, D. A., Sofer, T., Bertisch, S. M., & Jackson, C. L. (2019). Evening intake of alcohol, caffeine, and nicotine: Night-to-night associations with sleep duration and continuity among African Americans in the Jackson Heart sleep study. *Sleep*, *42*(11), zsz136. https://doi.org/10.1093/sleep/zsz136.

Stamatakis, E., Ekelund, U., Ding, D., Hamer, M., Bauman, A. E., & Lee, I.-M. (2019). Is the time right for quantitative public health guidelines on sitting? A narrative review of sedentary behaviour research paradigms and findings. *British Journal of Sports Medicine*, *53*, 377–382.

Stepanski, E. J., & Wyatt, J. K. (2003). Use of sleep hygiene in the treatment of insomnia. *Sleep Medicine Reviews*, *7*, 215–225.

Strong, A., Stoutenberg, M., Hobson-Powell, A., Hargreaves, M., Beeler, H., & Stamatakis, E. (2017). An evaluation of physical activity training in Australian medical school curricula. *Journal of Science and Medicine in Sport*, *20*, 534–538.

U.S. Department of Health and Human Services. (2018). *Physical activity guidelines for Americans* (2nd edition). Washington, DC: U.S. Department of Health and Human Services.

von Elm, E., Altman, D. G., Egger, M., Pocock, S. J., Gøtzsche, P. C., Vandenbroucke, J. P., et al. (2007). The Strengthening the Reporting of Observational studies in Epidemiology (STROBE) statement: Guidelines for reporting observational studies. *PLoS Medicine*, *4*, e296.

Watson, N. F., Badr, M. S., Belenky, G., Bliwise, D. L., Buxton, O. M., Buysse, D., et al. (2015). Recommended amount of sleep for a healthy adult: A Joint Consensus Statement of the American Academy of Sleep Medicine and Sleep Research Society. *Journal of Clinical Sleep Medicine*, *11*, 591–592.

Wright, K. P., Linton, S. K., Withrow, D., Casiraghi, L., Lanza, S. M., de la Iglesia, H., et al. (2020). Sleep in university students prior to and during COVID-19 Stay-at-home orders. *Current Biology*, *30*, R797–R798.