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Original Article

Physical activity, sleep and weight management in the COVID-19 era: a case report

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Abstract:
The evolving COVID-19 pandemic has caused community-wide lockdowns, resulting in social isolation. Currently the routine physical activities (PA) of millions of people worldwide has been disrupted, while there is strong recommendation for individuals to remain physically active by taking short active breaks. The case study reported aims at providing detailed information of a male individual who was physically active before the community-wide lockdown and attempted to remain physically active during the COVID-19 pandemic. It presents data, over eight weeks in total (4 x 2-week periods), of daily PA (steps and outdoor workout sessions), sleep monitoring (total and deep sleep time), and body weight and composition, as well as a structured exercise programme developed and implemented during the quarantine period. PA and sleep data were objectively measured with the use of a wearable PA monitor (i.e. Garmin Vivofit 4). The daily 30-min training programme included High Intensity Circuit Training (HICT) with the use of the 7 Minute Workout® app for Android, as well as body weight training (e.g. push-ups, squats). Results showed that PA based on step count has plummeted during self-isolation measures, however a home-based, individualized, app-driven HICT and body weight training programme, under the continuous monitoring of an exercise expert, has the potential to outweigh the detrimental effects of lack of movement. In order to increase daily PA up to the level before the lockdown, active commuting is an indispensable factor. Lastly, insufficient sleep quality and duration may undermine weight maintenance success and exercise performance. Implications related to these themes are further discussed.
Key Words*:* **7-minute workout, home-based training, exercise, self-isolation, lockdown, app-based programme, confinement.**

Introduction

The evolving COVID-19 pandemic is a major cause of concern worldwide (Wu & McGoogan, 2020). The situation has evolved rapidly with global case counts and deaths increasing day by day. The World Health Organization declared the COVID-19 outbreak a pandemic on 11th March 2020 and rated the global risk assessment as very high. Different treatment and prevention strategies have emerged over the last few months, and health authorities [Centers for Disease Control and Prevention (CDC), 2020; World Health Organization (WHO), 2020] have issued safety recommendations for taking simple precautions to reduce exposure to and transmission of the virus. A series of multifaceted public health interventions (e.g. traffic restriction, social distancing, home quarantine, centralized quarantine, and community-wide lockdowns) is temporally associated with improved control of the COVID-19 outbreak in Wuhan and may inform public health policy in other countries and regions (Rahmati-Ahmadabad & Hosseini, 2020). In addition, a 14-day quarantine is applied to subjects coming from endemic areas or who had contact with confirmed cases in most European countries (Lombardi et al., 2020).

Months of closures and unprecedented community-wide lockdowns, resulting in social isolation due to the guidance for people to stay at home in quarantine to prevent the spread of this infectious disease (Kraemer et al., 2020), have inevitably disrupted the routine physical activities (PA) of millions of people worldwide. Prolonged home stays can increase behaviors that lead to inactivity and contribute to anxiety and depression, which in turn can lead to a sedentary lifestyle known to result in a range of chronic health conditions (Chen, Mao, Nassis, Harmer, Ainsworth, & Li, 2020; Dominski & Brandt, 2020). For example, a recent study on female students aged 17-19 years showed that the PA restrictions due to the COVID-19 pandemic led to a decrease in their functional state, which was reflected in an increase in the resting heart rate 1.83 %, an increase in systolic blood pressure by 3.82 %, and a deterioration in the respiratory system by 3.19 % (Mozolev, Polishchuk, Kravchuk, Tatarin, Zharovska, & Kazymir, 2020).

The general recommendation specific to exercise and PA environments, based on research and official guidelines, is to avoid exercise in indoor environments with higher occupancy, and if performing outdoor exercise (e.g. walking, running, or cycling), there is a need to keep larger social distances or adopt a side-by-side arrangement, while there is a strong recommendation for individuals to remain physically active by taking short

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active breaks and avoiding excessive sedentary periods (Chen, Mao, Nassis, Harmer, Ainsworth, & Li, 2020; Dominski & Brandt, 2020; Rodríguez, Crespo, & Olmedillas, 2020). The general population should perform multicomponent full body programmes including aerobic, strengthening, balance, and stretching exercises (Rodríguez, Crespo, & Olmedillas, 2020). PA can be recommended as a non-pharmacological, inexpensive, and viable way to cope with COVID-19 (Rahmati-Ahmadabad & Hosseini, 2020) and has clear preventive potential on many chronic diseases that are considered to be risk factors for COVID-19 outcomes (Burtscher, Millet, & Burtscher, 2020). Individuals should keep in mind that being active does not need to rely on fancy equipment, and if they own a smartphone, computer or television with internet access, there are many online resources to help them remain active (Neubeck et al., 2020).

Currently big data, coupled with data from wearable monitors and routine surveillance systems, are proposed to be the most practical and least biased way to identify population-level PA trends (Ding, del Pozo Cruz, Green, & Bauman, 2020). With the use of big data, researchers estimated that in Australia, the UK, and the USA community interest in exercise surged immediately following the lockdown, peaked within the first two weeks, then declined but remained at a higher level than before the lockdown (Ding et al., 2020). More big data from Garmin and Withings wearable monitors suggest that despite step-count decreases during COVID-19 early phase of physical isolation (March 2020), exercise, particularly indoors and virtual, increased substantially (Felber, 2020; Stables, 2020). The severity of the decline in steps varied by country, with European countries showing a more dramatic change, ranging from a 7% to 38% decline in step counts during the week ending March 22, 2020 (Fitbit Staff, 2020), and this decline continued till early June (Felber, 2020). Following this period, Apple (2020) and Google (2020) mobility reports demonstrated that there has been an increase in movement trends over time (June-July 2020). On the other hand, the actual change in the population prevalence of PA is not yet known, due to various issues with big data insufficient information (Ding et al., 2020).

This case study aims at providing a detailed report of a male individual who was physically active before the community-wide lockdown and attempted to remain physically active during the COVID-19 pandemic. It presents data, over 8 weeks in total (4 x 2-week periods), of daily PA (steps and outdoor workout sessions), sleep monitoring (total and deep sleep time), and body weight and composition, as well as a structured exercise programme developed and implemented during the quarantine period. Similar 'small data' studies are necessary because they provide in-depth information of actual behavioural change in the population PA prevalence.

Material & methods

Sheldon (pseudonym for anonymity purposes) is a 35-year-old physically active male (baseline body height 1.85 m; body weight 84.4 kg; fat percentage 23.5%), with no known health conditions that would deter him from participating in structured PA. He is currently single, does not have any children, lives on his own and works in the bank sector.

He accepted to participate in this study and provided written informed consent. During the eight weeks of the case report, he had to amend his PA habits due to community-wide lockdown and self-isolation measures. Meanwhile, he was encouraged not to change his dietary habit, and this was confirmed with the use of a modified food frequency recall questionnaire for the previous week. The primary measures were daily steps, exercise sessions and sleep quantity and quality (total sleep and deep sleep time), which were estimated daily with the use of a wearable PA monitor (i.e. Garmin Vivofit 4) and the respective software (i.e. Garmin Connect). Body weight and fat percentage (secondary outcomes) were measured weekly with the use of a weighting scale with bioelectrical impedance (i.e. Omron BF-511) in the morning, after a 10-h fast. Data were collected for a total of eight weeks, classified in 2-week periods, and were analyzed descriptively.

The case results

Initial 2-week period

The two weeks before lockdown and self-isolation was considered the first period, when no COVID-19 specific interventions were imposed. Sheldon was actively commuting daily to work (i.e. walking) and was exercising outdoors three times per week (i.e. running). The average daily steps computed were 8,557±4,004 steps, the average time spent for exercise during outdoor running was 44 min 29 sec±15 min 22 sec, with a mean pace 6 min 9 sec±1 min 30 sec and mean distance travelled 7.16±1.15 km. Lastly, Sheldon's average body weight was 84.47±.12 kg and body fat 23.67±.67 %. Data of daily sleep monitoring revealed that he slept for 7 h 39 min±1 h 4 min, while his deep sleep time was 3 h 4 min±53 min. Detailed data information is presented in Figure 1a.

Self-isolation 2-week period

During the second period, city lockdown with traffic suspension and home quarantine and self-isolation was imposed. Sheldon had to stay at home all the time and work and interact with everyone remotely through virtual communication portals. This also meant that he had to quit exercising outdoors (i.e. no running sessions during this period). In order to remain physically active, he engaged with home-based physical training. An exercise specialist (trainer) created, based on international guidelines and Sheldon's request, a daily 30-min training programme, aiming to undertake at least 30 min of moderate PA every day and/or at least 20 min of

vigorous PA every other day. Ideally, a combination of both intensities of PA is preferable in addition to practicing strengthening-type activities on a regular basis (U.S. Department of Health and Human Services, 2018). The training sessions mainly included High Intensity Circuit Training (HICT) with the use of the 7 Minute Workout® app for Android (Adamakis, 2018), as well as body weight training (Hammami, Harrabi, Mohr, & Krustrup, 2020). The 7 Minute Workout was chosen because it can affect the nutritional status (decrease in weight, fat mass and waist circumference) in healthy normal weight individuals who do not alter any of their dietary habits (Mattar, Farran, & Bakhour, 2017). Other components of the programme (e.g. push-ups) were included due to their no-cost nature and their association with higher functional status and lower cardiovascular disease risk (Yang et al., 2019).

The entire training session had the following structure: 1. two minutes warm up; 2. First 7 Minute Workout; 3. three sets of 100 abdominal crunches; 4. three sets of 15 push-ups; 5. Second 7 Minute Workout; 6. three sets of 15 squats; 7. three minutes cool down. During the entire session, which was held early in the morning, the trainer remained virtually connected with Sheldon through Skype©, to monitor the training, provide insights into continued training options, encourage self-care and, ultimately, assist him in establishing a daily PA routine.

Sheldon followed in detail the programme and performed 14 training sessions in two weeks (30-min session per day). The average daily steps computed during this period were reduced to 2,756±1,083 steps. On the other hand, Sheldon's average body weight (84.65±.78 kg) and body fat (24.05±.78%) remained unaltered. Data of daily sleep monitoring showed an overall increase, as his sleep time (8 h 21 min±34 min), as well as deep sleep time (3 h 22 min±25 min) increased. Detailed data information is presented in Figure 1b.

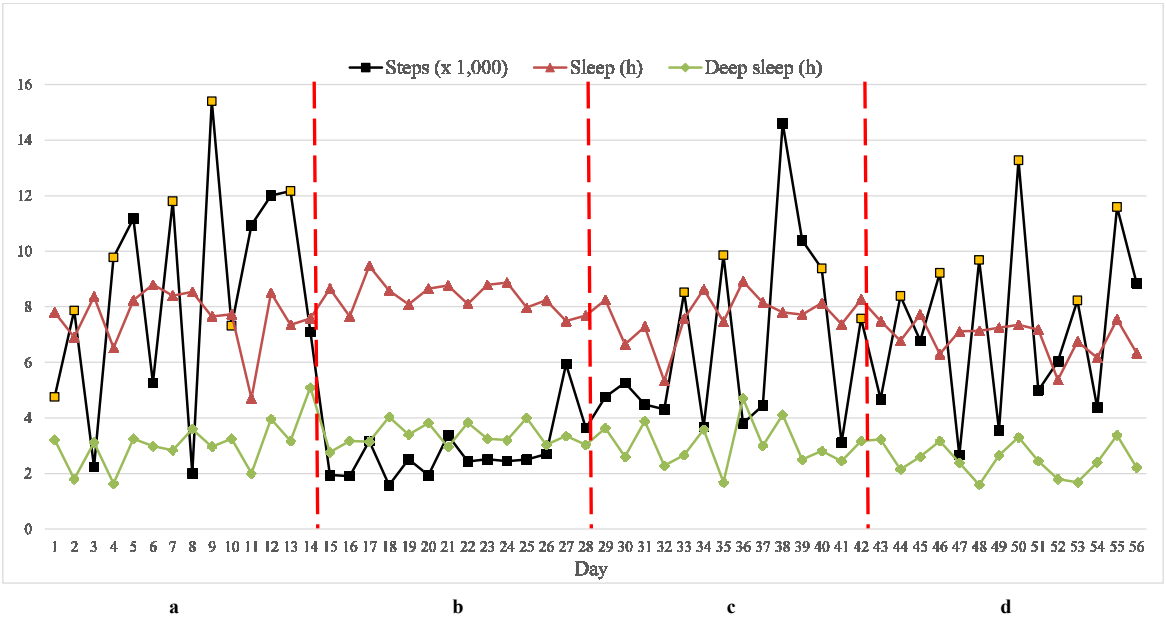

Figure 1. *Steps and sleep (total and deep) duration during: (a) initial; (b) self-isolation; (c) traffic limitations; (d) follow-up periods (in orange square the days including outdoor running).*

Traffic limitations 2-week period

During the third period, city lockdown with traffic limitations remained the same, however measures of self-isolation and home quarantine were abandoned. Due to work closure, Sheldon had to continue working remotely from home, so actively commuting to work was not part of his daily PA. On the other hand, he was able to return to his normal outdoor running sessions, and the only limitation was that individuals performing outdoor exercises had to inform via sms a central governmental portal. Sheldon was advised to follow the training programme developed during the previous phase, however the trainer did not supervise or monitor his training.

Overall, Sheldon exercised indoors only two times in total (once per week) and, in addition, he went running twice per week (four times in total). The average daily steps computed were 6,728±3,389 steps, the average time spent for outdoor running was 39 min 18 sec±3 min 22 sec, with a mean pace 6 min 2 sec ±17 sec and mean distance covered 6.50±0.46 km. Sheldon's average body weight was 84.30±.28 kg and body fat 24.60±.14 %. Data of daily sleep monitoring showed that he slept for 7 h 41 min±54 min, while his deep sleep time was 3 h 5 min±49 min. Detailed data information is presented in Figure 1c.

Follow-up 2-week period

Two months after the third period, Sheldon share his daily data for two more weeks. During this time, all lockdowns and self-isolation measures were removed, however Sheldon was still working remotely, so he was not actively commuting to work. He did not follow the exercise programme created 2 months ago, however he returned to his pre-quarantine exercise routine (i.e. three running sessions per week).

The average daily steps computed were 7,308±3,113 steps, the average time spent during outdoor running was 41 min 13 sec±7 min 58 sec, with a mean pace 6 min 15 sec±16 sec and mean distance travelled 6.23±.52 km. Lastly, Sheldon's average body weight was 84.45±.07 kg and body fat 24.65±.35 %. Data of daily sleep monitoring revealed that he slept for 6 h 53 min±39 min, while his deep sleep time was 2 h 30 min±36 min. Detailed data information is presented in Figure 1d.

Discussion

As the COVID-19 pandemic continues to evolve, it has a major impact on PA levels for over 30 million people around the globe (Fitbit Staff, 2020), due to unprecedented community-wide lockdowns, quarantine and self-isolation measures. Individuals cannot keep up with their PA and exercise routines, active transportation is reduced to a minimum and prolonged home stay may lead to increased sedentary behaviors. The need to maintain regular PA while taking precautions is necessary and routinely exercising in a safe home environment is an important strategy for healthy living during the coronavirus crisis (Ding et al., 2020).

The case study presented (Sheldon) was an internally motivated individual who was physically active before the pandemic, as revealed from the data collected during the initial 2-week period. During lockdown and self-isolation period, when Sheldon was not able to exercise outdoors, there was a significant decrease in daily steps taken (Figure 1b), however his body weight and fat percentage were not altered. Unsurprisingly, the number of daily steps recorded by Garmin monitors had plummeted over this period, however individuals had embraced indoor cardio training and virtual workouts (Felber, 2020; Stables, 2020). Thus, Sheldon's positive weight management was related to a PA counterbalance based on home-related supervised exercise, including HICT, the use of an app and body weight training, under the supervision of an expert trainer. In a previous study, commercially available apps improved body composition to the same extent as supervised exercise sessions, showing that both approaches are equally effective (Berglind, Yacaman-Mendez, Lavebratt, & Forsell, 2020), and this combined approach seem to outweigh the detrimental effects of lack of movement. Also, during this period, Sheldon's sleep duration and quality increased significantly. These changes might have also affected weight management, since both sleep quantity and quality are associated with weight maintenance status and reduced risk of obesity (Beccuti & Pannain, 2011) and weight gain during the pandemic (Felber, 2020), and this is more evident in males (Yannakoulia, Anastasiou, Karfopoulou, Pehlivanidis, Panagiotakos, & Vgontzas, 2017).

Over the next two periods following self-isolation (traffic limitations and 2-month follow-up) Sheldon restarted outdoor running and gradually increased his PA level. This PA recuperation pattern was obvious in big data reports (Apple, 2020; Ding et al., 2020), where community interest in exercise surged immediately following the lockdown, peaked within the first two weeks, then declined but remained at a higher level than before the lockdown (Ding et al., 2020). Even though data from the 2-month follow-up did not escalate higher than before the initial period (≈1,200 daily step shortage), he managed to keep the same PA pattern of outdoor running three times per week and control his body weight. The main reason behind the lack of accumulation of more daily steps was the fact that he continued working remotely from home and, thus, he had abandoned active commuting to work, which can be a major contributor to total PA (Gbadamosi, Clarke-Cornwell, Sindall, & Granat, 2020). Since returning to work currently might be safe if security precautions are followed to reduce exposure and transmission of the virus (Larochelle, 2020), going back to normal working conditions might be an adequate approach for low-risk individuals to increase daily active commuting levels and enhanced overall PA. In addition, Sheldon's lower overall performance during outdoor exercise in follow-up time (less time running, higher pace and lower distance travelled) can be partially attributed to poor sleep duration and quality during this period, since sleep extension is highly correlated with the most beneficial effects on subsequent performance measures (Bonnar, Bartel, Kakoschke, & Lang, 2018).

Certain limitations exist in the present study, mainly because this is a case report. Findings cannot be generalised at a population level and causation cannot be ascertained. Also, other aspects of Sheldon's wellbeing (physical, mental and social) that might have influenced his PA behaviour were not reported, and this could be part of further research in case that comparable situations (i.e. lockdown) should emerge. Lastly, more rigorous inferential statistical analysis was not deemed appropriate, since there was only one participant.

Conclusions

This specific case report provides some useful insights for PA and exercise of healthy adults during and after the COVID-19 pandemic, allowing to formulate helpful hypothesis for further research. PA based on step count has plummeted during self-isolation and quarantine measures, however an indoor, individualized, app-driven HICT and body weight training programme, under the monitoring of an exercise expert, has the potential to outweigh the detrimental effects of lack of movement. Home-based PA, indoor cardio and virtual workouts

(e.g. climb stairs, hop, skip jump, dance, Zumba, yoga, strength exercises or even active video-gaming in short bursts of activity) are viable alternatives for increasing overall PA levels (Hammami et al., 2020; Jurak et al., 2020). Also, there is a huge variety of freeware PA apps that can be used for this purpose, and these apps can be also helpful for individuals who have been financially affected by the pandemic. Furthermore, to increase daily PA up to the level before the lockdown, active commuting is an indispensable factor and should be promoted as such. In addition, insufficient sleep quantity and quality may undermine weight maintenance success and exercise performance. In order to improve sleep patterns, individuals could keep a regular night and wake-time schedule, create structure to each day, schedule a brief (15-20 minute) time during day for reflection, among other recommendations (Singh & Edwards, 2020).

Currently, there is no vaccine for the prevention or treatment of the illness caused by COVID-19, however there is a strong health rationale for continuing PA to stay physically active and healthy, following infection control and safety precautions. Extreme lockdown measures for postponing the pandemic wave for many months, which may have even worse consequences than a pandemic wave that runs an acute course (Ioannidis, 2020), may further have irreversible effects on individuals' PA levels and intention to remain physically active.

Conflicts of interest - The author does not have any conflicts of interest to declare.

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