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Research article

The impact of physical activity on psychological health during Covid-19 pandemic in Italy

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ABSTRACT

The worldwide spread of COVID-19 has upset the normality of Italian daily life, forcing population to social distancing and self-isolation. Since the containment precautions also concern sport-related activities, home workout remained the only possibility to play sports and stay active during the pandemic.

The present study aimed to examine changes in the physical activity levels during self-quarantine in Italy, and the impact of exercise on psychological health.

A total of 2974 Italian subjects has completed an online survey, but only 2524 subjects resulted eligible for this study. The questionnaire measured the total weekly physical activity energy expenditure before and during quarantine (i.e. the sum of walking, moderate-intensity physical activities, and vigorous-intensity physical activities) in Metabolic Equivalent Task minutes per week (MET–min/wk) using an adapted version of International Physical Activity Questionnaire and their psychological well-being using the Psychological General Well Being Index. Of the 2524 Italian subjects included in the study, 1426 were females (56.4%) and 1098 males (43.6%). Total physical activity significantly decreased between before and during COVID-19 pandemic (Mean: 2429 vs. 1577 MET–min/wk, ****$p < 0.0001$), in all age groups and especially in men (Female, mean: 1994 vs. 1443 MET–min/wk, ****$p < 0.0001$; Male, mean: 2998 vs. 1754 MET–min/wk, ****$p < 0.0001$). Furthermore, a significant positive correlation was found between the variation of physical activity and mental well-being ($r = 0.07541$, ***$p = 0.0002$), suggesting that the reduction of total physical activity had a profoundly negative impact on psychological health and well-being of population.

Based on this scientific evidence, maintaining a regular exercise routine is a key strategy for physical and mental health during a forced rest period like the current coronavirus emergency.

1. Introduction

In late December 2019, an epidemic of cases with unknown low respiratory infections occurred in Wuhan, the largest metropolitan area in China's Hubei province. This disease was caused by a new coronavirus (CoV) named severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), responsible of the coronavirus disease 2019 (COVID-19) as announced by World Health Organization (WHO) on 11 February 2020. In the following weeks, infections spread across China and other countries, including Italy, and COVID-19 epidemic has become a global health threat. In Italy, according to last updated of the Italian Ministry of Health (May 1, 2020 at 6.00 pm) it has been turned out 17.569 patients with symptoms, 1.578 intensive care, 81.769 home isolation, 100.943 total currently positive, 78.249 dismissed/healed, 28.236 deaths, 207.428 total cases [1]. Total infected and total death by Italian regions is displayed in Table 1. The Italian patients' median age was 62 years, the

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Table 1. Contagions of COVID-19 in Italy by region at 13th of June 2020. https://lab24.ilsole24ore.com/coronavirus/.

Total Italian population currently positive 28.997	Total Cases From the beginning of the Epidemic 236.305	Total Italian population currently Deaths 34.223	Total Italian population currently Healed 173.085
Italian Regions	Total Infected	Total Deaths	Total Healed
Lombardia	91.204	16.405	57.775
Piemonte	30.989	3.996	24.096
Emilia Romagna	28.028	4.196	22.015
Veneto	19.199	1.967	16.383
Toscana	10.165	1.080	8.575
Liguria	9.871	1.516	8.106
Lazio	7.916	781	4.913
Marche	6.752	993	5.009
Campania	4.608	430	3.832
Trentino Alto Adige	7.051	755	6.127
Puglia	4.515	532	3.544
Sicilia	3.455	279	2.335
Friuli Venezia Giulia	3.290	342	2.840
Abruzzo	3.271	453	2.290
Umbria	1.436	76	1.336
Sardegna	1.363	131	1.190
Valle d'Aosta	1.191	144	1.038
Calabria	1.161	97	1.017
Basilicata	401	27	362
Molise	439	23	302

median age of fatalities is 80.5 years old, whereas few cases of COVID-19 have been found in very young people [1]. As indicated by Wu and co-authors [2], the rate of death drastically increased in patients already affected by one or more pathologies, such as diabetes and cardiovascular disease. Understanding the clinical manifestations of COVID-19 is important, although they are nonspecific and ranging from asymptomatic infection to severe respiratory failure. Common symptoms of COVID-19 comprise fever, cough, myalgia, fatigue and dyspnea [3, 4]. The transmission of COVID-19 occurs mainly through droplet and close contact [5]. Its transmission through oral or conjunctival way is still unknown, but SARS-CoV-2 has been found in tears, and Lu and coauthors reported that human conjunctival epithelium could be easily contaminated by infected droplets or other body fluids [6]. Given powerful transmissibility of SARS-CoV-2 by human-to-human, since the outbreak of COVID-19 in Italy, response efforts by the Italian Government have been directed to restrain the spread of the virus. A lockdown was imposed on some northern region on 8 March, and within days, the quarantine was extended to throughout the peninsula. To ensure social distancing and limit the movement of the population, schools, public places and businesses were shutdowns. Moreover, people can move away from their home only to do essential work (healthcare and social care sectors, police and armed forces, firefighting, water and electricity supply) or perform essential activities (health visits, purchasing medicines or food). Although this strategy has been reported to be efficacy for containing the COVID-19 outbreak, also the quarantine may be associated with several undesirable effects, due to alteration of social habits. In particular, prolonged self-isolation has a negative impact on the psychological response, promoting post-traumatic stress symptoms, confusion, and anxiety [7]. Moreover, quarantine leads to physical inactivity, which contributes to adverse health changes such as premature ageing, obesity, cardiovascular vulnerability, muscle atrophy, bone loss and decreased aerobic capacity [8]. Literature has largely described the positive role exerted by physical activity to ameliorate general health, acting on heart, circulatory and respiratory as well as immune function [9, 10]. Exercise is able to counteract metabolic disorder, bone, muscle, joint pathologies and neurodegenerative disease [11, 12, 13, 14, 15, 16, 17]. Long term detraining, as for this COVID-19 forced stop, leads to a marked decline of the maximal oxygen consumption (VO2max), reduced endurance capacity, loss of muscle strength and mass, tendon ruptures and reduced joint tribology [18]. Regular physical activity is a key health behaviour from a public health perspective, as it has a remarkable impact on health. In respect to upper respiratory tract infection (URTI), caused by pathogens like COVID-19, physical activity may ameliorate pathological outcomes, by promoting the release of stress hormones responsible for reducing excessive local inflammation within the respiratory tract and by inducing the secretion of anti-inflammatory cytokines, such as IL-4 and IL-10, in order to prevent excessively prolonged T helper type 1 (Th1) cell population activity against the pathogen, leading to cell damage and necrosis [19, 20]. Several evidences have also demonstrated that physical activity can be effective in ameliorating the mental well-being and having the potential to prevent symptoms of mental health disorder such as depression and anxiety [21, 22, 23, 24]. Based on these evidences, the purpose of this survey study was to examine (1) changes in the physical activity levels during self-quarantine in Italy; (2) the correlation between physical activity and well-being of individuals. To this end, it has been used an online questionnaire containing an adapted version of short-form of International Physical Activity Questionnaire (IPAQ-SF), to assess the practised level of physical activity and Metabolic Equivalents (MET) energy expenditure, and the Psychological General Well Being Index (PGWBI) to evaluate psychological and general well-being.

2. Materials and methods

2.1. Design

The present study is a quick, large cross-sectional online survey realized through Google Forms web survey platform (Google LLC, Mountain View, CA, United States). The online survey was communicated through the social media such as Instagram, LinkedIn, Facebook and via official channels of the University of Catania, University of Palermo, University of Perugia and by the Italian Society of Movement and Sport Sciences (SISMES). Moreover, via WhatsApp and e-mails, it was shared to personal contacts of the research group members and of the University students. Before starting the questionnaire, the online survey, totally anonymous and not traceable to identity of participants, including a brief description of the study, its aim, and the declarations of anonymity and confidentiality as follow: “The data of this survey are anonymous, confidential and their confidentiality will be guaranteed. We remind you that participation is voluntary and therefore, can withdraw or renounce at any time. The participant, informed according to the methods and purposes of the research described above, expresses his/her consent to his/her participation, having the guarantee that his/her personal data will be processed anonymously”. All subjects participating in the online survey gave their informed consent before participation. The study was approved by the local ethics committee of the Research Center on Motor Activities (CRAM), University of Catania (Protocol Number: CRAM-011-2020-16/03/2020), and it was conducted in accordance with the Declaration of Helsinki.

2.2. Participants

A total of 2974 Italian subjects of different social classes and level of instruction completed the online Google form questionnaire over a period of 30 days (from April 1st to April 30th, 2020) during COVID-19 emergency in Italy. To minimize the impact of errors, a cleaning process was adopted in order to remove ineligible cases identify meaningless data, representing invalid questionnaire responses due to the unwillingness of the participant to provide a valid response according to American Association for Public Opinion Research addressed in “Standard Definitions” [25]. Then, the sample comprised 2524 Italian subjects, 1426 females (56.4%) and 1098 males (43.6%), was included in the study.

2.3. Questionnaire

The online questionnaire (https://forms.gle/8254mc5WfeKs8nDz8) administered to the participants included five explanations of the kind of physical activity and 55 questions comprising demographic, anthropometric, socioeconomic data and health status shown in Table A of supplementary materials, an adapted version of short-form of International Physical Activity Questionnaire (IPAQ-SF) and the Psychological General Well Being Index (PGWBI). The questions of IPAQ-SF allowed to assess physical activity by providing information about the minutes per day or days per week, at any time of the day, spent doing activities before COVID-19 emergency and in the last four weeks. Participants reported the frequency and duration of different types of activity: vigorous (i.e. heavy lifting, performing intense aerobic exercises, using bike or treadmill); moderate (i.e. carrying light loads and bicycling at a regular pace carry, work out in the garden); walking activities, as well as the average time, spent sitting on a weekday, including sitting at work. Responses were converted to Metabolic Equivalent Task minutes per week (MET-min/week) though automatic scoring of the IPAQ-S [26]. Based on the IPAQ recommendations for scoring protocol, participants of the study was classified in three different groups of physical activity considering the MET–min/wk of the sum of walking, moderate-intensity physical activities, and vigorous-intensity physical activities: low active (<600 MET–minutes/week); moderate active (≥600 MET–minutes/week) and high active (≥3000 MET–minutes/week) (http://www.ipaq.ki.se).

To estimate a subjective perception of well-being in the last four weeks during COVID-19 emergency, the online questionnaire also comprised 22 items of PGWBI, which evaluate psychological and general well-being of subjects in six health-related quality of life domains comprising: anxiety, depressed mood, positive well-being, self-control, general health and vitality. Each response has six possible scores from 0 (most negative option) to 5 (most positive option), and the global summary between 0 and 60 reflect severe distress, between 61 and 72 reflect moderate distress, and between 73 and 110 points to positive psychological well-being, with a maximum of 110 points, representing the best achievable level of well-being [27].

2.4. Statistical analysis

Statistical analysis was performed using GraphPad Instat® Biostatistics version 3.0 software (GraphPad Software, Inc. La Jolla, CA, USA). Analysis of variance (1way ANOVA, Kruskal-Wallis test with Dunn's multiple comparisons test) was used for comparison between more than two groups; Unpaired t test with Welch's correction was used for comparison between two groups. p-values of less than 0.05 were considered to be statistically significant (*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$; ****$p < 0.0001$ and ns: not significant). Data are presented as the Mean ± SEM. The relationships between physical activity and psychological well-being were assessed by Pearson correlation analysis.

3. Results

3.1. General characteristics of the study populations

Baseline characteristics of the study subjects are displayed in Table 2. Overall, the study sample (n = 2524) comprised 56.4% of females and 43.6% of males. Participants were divided into four age groups: young aged <21 (n = 346); young adult aged 21–40 (n = 1178); adults aged 41–60 (n = 704) and over 60 age (n = 296). The mean height was 171.80 ± 9.84, the weight 66.10 ± 13.66 kg, and body mass index (BMI) was 22.26 ± 3.52 kg/m^2. The BMI was then split into three categories: underweight (BMI < 18.5), normal weight (BMI 18.5–24.9) and overweight (BMI ≥25.0). As shown in Table 2, 66.63% of participants were classified as normal-weight subjects.

3.2. Comparison of physical activity before and during COVID-19 pandemic in Italy

Participants had to give information (before and during the COVID-19 quarantine) related to vigorous and moderate-intensity physical activity as well as walking activity and sedentary behaviours. Vigorous-intensity physical activities comprising heavy lifting, use of home gym machines, work out/courses on the online platform and others fitness instruments, demand a hard physical effort that increases the breathing rate more frequently than normal. Moderate-intensity physical activities can include carrying a light load or performing aerobic exercises at a modest intensity. Examination of the total physical activity in MET– minutes/week demonstrated a statistically significant difference between before and during COVID-19 pandemic (Mean: 2429 *vs.* 1577 MET–min/wk, ****$p < 0.0001$) (Figure 1A). Specifically, scores of vigorous physical activity (Mean: 1109 *vs.* 766.6 MET–min/wk, ****$p < 0.0001$), moderate activity (Mean: 574 *vs.* 523.3 MET–min/wk, *$p = 0.0188$) and walking (Mean: 746 *vs.* 287.6 MET–min/wk, ****$p < 0.0001$) of subjects during COVID-19 emergency were significantly lower than those of the period before quarantine (Figure 1A).

Results of the IPAQ scoring showed that before COVID-19 emergency 23.06% of participants are low active (<600 MET–minutes/week), 35.18% are moderate active (≥600 MET–minutes/week) and 41.76% are high active (≥3000 MET–minutes/week).

During COVID-19 quarantine, percentage of low active individuals increased up to 39.62%, whereas 29.75% and 30.63% were moderate active and high active, respectively (Table 3).

As shown in Figure 1B, the levels of physical activity of participants classified before COVID-19 as high active and moderate active, drastically decreased during COVID-19 pandemic (Mean: 4400 *vs.* 2432 MET–min/wk, ****$p < 0.0001$; Mean: 1354 *vs.* 1077 MET–min/wk, ****$p < 0.0001$, respectively). These results suggest that the limitations imposed by quarantine, have induced that part of population that usually performed moderate and high levels of physical activity to decrease their regular and habitual level during the forced period. On the contrary,

Table 2. Characteristics of participants.

	Sample	
	n	%
Participants	2524	
Female	1426	56.4
Male	1098	43.6
	Age classifications	
Young	346	13.71
Young adults	1178	46.67
Adults	704	27.89
Over 60	296	11.73
	BMI levels	
Underweight	334	13.23
Normal weight	1707	67.63
Overweight	483	19.14

n, number; %, percentage, BMI, Body mass index.

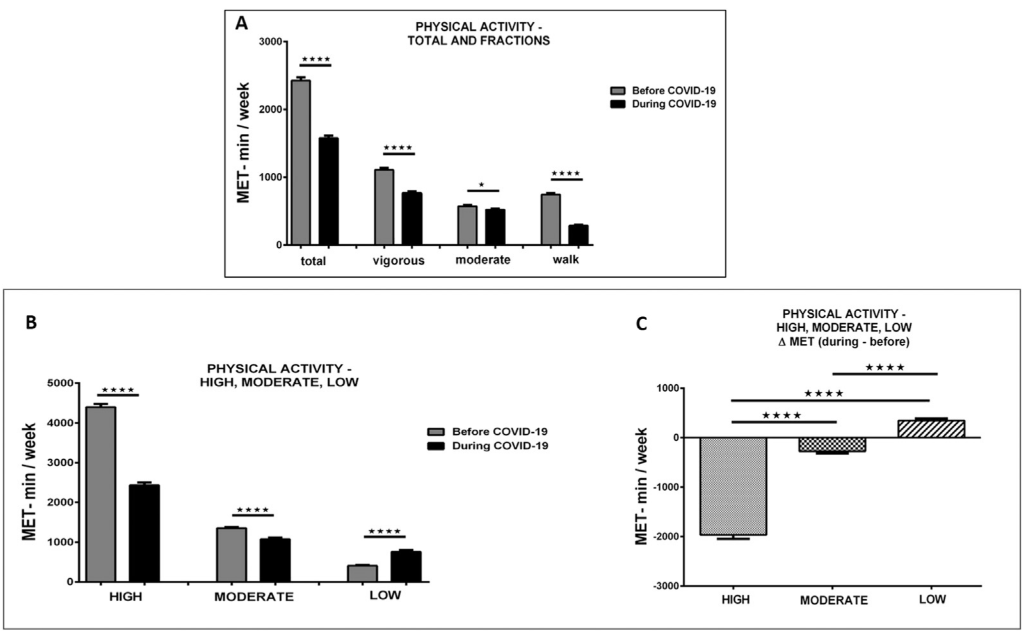

Figure 1. A. Total, vigorous, moderate physical activity and walking calculated in MET-minutes/week, before and during COVID-19. Data are expressed as mean ± SEM. ***p < 0.001 and *p = 0,0188 as determined by Unpaired t test with Welch's correction. B. Total physical activity in MET-minutes/week before and during COVID-19 of high active, moderate active and low active participants. Data are expressed as mean ± SEM. ****p < 0.0001 as determined by Unpaired t test with Welch's correction. C. Variation of total physical activity in MET-minutes/week between before and during COVID-19 in high active, moderate active and low active groups. Data are expressed as mean ± SEM. ****p < 0.0001 as determined by one-way ANOVA followed by Kruskal-Wallis test with Dunn's multiple comparisons test.

Table 3. Classification of participants according to IPAQ scoring before and during COVID-19.

	Physical activity level before COVID-19 quarantine		Physical activity level during COVID-19 quarantine	
	n	%	n	%
Low active	582	23.06	1000	39.62
Moderate active	888	35.18	751	29.75
High active	1054	41.76	773	30.63

n, number; %, percentage.

individuals classified before COVID-19 as low active significantly increased total weekly physical activity energy expenditure during quarantine (Mean: 408.1 vs 755.3 MET–min/wk, ****p < 0.0001). This unexpected result could be due to the greater housework activities carried out by these subjects forced to stay at homes, compared to before quarantine. Accordingly, the variation of MET–min/week (i.e. during *vs* before) is positive only in the low group. Moreover, Δ-MET values are statistically different among the three groups (****p < 0.0001) (Figure 1C).

Regarding gender classifications, total physical activity between before and during quarantine significantly decreased in MET–min/week in both groups (Female, mean: 1994 *vs.* 1443 MET–min/wk, ****p < 0.0001; Male, mean: 2998 *vs.* 1754 MET–min/wk, ****p < 0.0001)

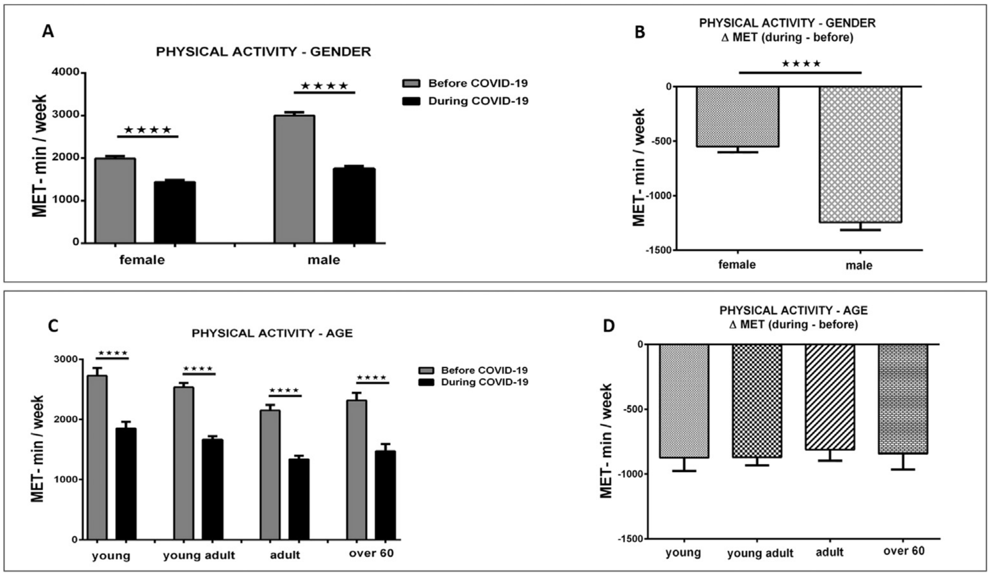

Figure 2. A. Total physical activity in MET-minutes/week before and during COVID-19 in relation to gender variable. Data are expressed as mean ± SEM. ****p < 0.0001 as determined by Unpaired t test with Welch's correction. B. Variation of total physical activity in MET-minutes/week between before and during COVID-19 in female and male groups. Data are expressed as mean ± SEM. ****p < 0.0001 as determined by Unpaired t test with Welch's correction. C. Total physical activity in MET-minutes/week before and during COVID-19 in relation to age variable. Data are expressed as mean ± SEM. ****p < 0.0001 as determined by Unpaired t test with Welch's correction. D. Variation of total physical activity in MET-minutes/week between before and during COVID-19 in young, young adult, adult and over 60 groups. Data are expressed as mean ± SEM. There was no statistically significant difference between groups as determined by one-way ANOVA followed by Kruskal-Wallis test with Dunn's multiple comparisons test.

(Figure 2A). Moreover, the male group showed highly significant variation of Δ-MET as compared to females (****p < 0.0001) (Figure 2B).

Based on the age classifications, total physical activity significantly decreased during quarantine in young, young adult, adult and over 60 participants (Mean: 2726 *vs.* 1852 MET–min/wk, ****p < 0.0001; Mean: 2535 *vs.* 1664 MET–min/wk, ****p < 0.0001; Mean: 2150 *vs.* 1339 MET–min/wk, ****p < 0.0001; Mean: 2316 *vs.* 1473 MET–min/wk, ****p < 0.0001, respectively) (Figure 2C). Instead, no significant difference in Δ-MET–min/week was found among these groups (Figure 2D).

3.3. Correlation between physical activity and psychological well-being during COVID-19 emergency in Italy

PGWBI scores of six health domains comprising anxiety, depressed mood, positive well-being, self-control, general health and vitality of participants divided by gender, age, and levels of physical activity are displayed in Table 4. The total score of female and low active groups reflected moderate distress, whereas the other groups belong to positive psychological well-being.

To evaluate if changes in physical activity levels during the COVID-19 emergency affect psychological well-being, a Spearman's ρ correlation was run to determine the relation between Δ-MET–min/week and total PGWBI score. As shown in Figure 3A, a significant positive correlation was found between the variation of physical activity and mental well-being, suggesting that reduction of total physical activity is related to worse status of psychological well-being (r = 0.07541, ***p = 0.0002).

Interestingly, the correlation between physical activity and psychological well-being depending on gender showed a higher positive correlation in female (r = 0.1758, ****p < 0.0001) as compared to male group (r = 0.06356, *p = 0.0366), suggesting that variations in physical activity habits could more influence the psychological status of women than men (Figure 3B-C).

As shown in Figure 3E, a significant positive correlation was detected between the variation of total activity and PGWBI score in young adult group (r = 0.1168, ****p < 0.0001), whereas no significant association was found between physical activity and psychological well-being in the other age groups (Figure 3D-G).

Lastly, the same correlation was evaluated for the three categories of participants, classified before COVID-19, as high active, moderate active and low active. As shown in Figure 3H-I, a significant correlation was found in high active (r = 0.1322, ****p < 0.0001) and moderate active (r = 0.1035, **p = 0.0020) groups. No positive correlation between variation of total activity and PGWBI score was found in low active group (Figure 3L) (r = 0.08157, p = 0.0546).

Table 4. PGWBI subscales score by gender, age and physical activity levels.

	Anxiety	Depression	Positive well-being	Self- control	General health	Vitality	PGWBI total score
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Gender							
Female	17.68 (±0.80)	9.68 (±0.15)	13.77 (±1.06)	9.81 (±1.08)	9.00 (±0.28)	12.06 (±0.45)	72.00 (±16.13)
Male	19.41 (±0.70)	10.77 (±0.24)	14.83 (±0.91)	10.72 (±1.05)	10.54 (±0.31)	13.75 (±0.41)	80.03 (±13.72)
Age group							
Young	18.45 (±0.75)	10.16 (±0.18)	14.24 (±0.98)	10.46 (±1.00)	10.00 (±0.30)	12.99 (±0.42)	76.30 (±16.10)
Young adults	18.45 (±0.76)	10.19 (±0.18)	14.27 (±0.99)	10.20 (±1.07)	9.20 (±0.29)	12.76 (±0.43)	75.07 (±16.04)
Adults	18.51 (±0.74)	10.16 (±0.19)	14.22 (±0.98)	10.22 (±1.06)	9.82 (±0.28)	12.82 (±0.44)	75.75 (±14.71)
Over 60	18.15 (±0.68)	9.99 (±0.25)	14.12 (±1.03)	9.93 (±1.12)	9.51 (±0.29)	12.63 (±0.41)	74.33 (±13.53)
Physical activity level during COVID-19 quarantine							
Low active	16.29 (±0.76)	10.10 (±0.18)	14.03 (±1.03)	10.13 (±1.09)	9.29 (±0.31)	12.1 (±0.43)	71.94 (±16.93)
Moderate active	19.16 (±0.74)	10.10 (±0.18)	14.31 (±0.97)	10.18 (±1.09)	9.90 (±0.26)	12.88 (±0.43)	76.53 (±14.52)
High active	18.62 (±0.75)	12.05 (±0.20)	14.42 (±0.96)	10.34 (±1.01)	9.99 (±0.28)	12.95 (±0.43)	78.37 (±14.48)

SD, standard deviation.

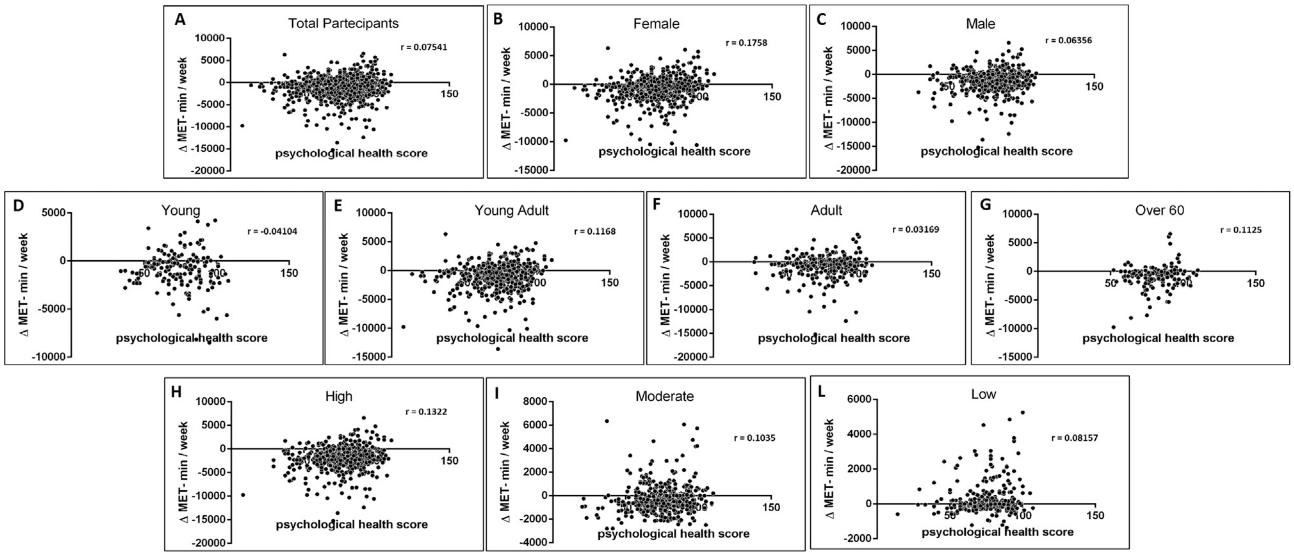

Figure 3. A. Correlation between Δ-MET–min/week and total PGWBI score. r = 0.07541 ***p = 0.0002 as determined by Spearman's ρ correlation. B–C. Correlation between total Δ-MET–min/week and total PGWBI score in relation to gender variable. Female group: r = 0.1758, ****p < 0.0001; male group: r = 0.06356, *p = 0.0366 as determined by Spearman's ρ correlation. D,E,F,G. Correlation between total Δ-MET–min/week and total PGWBI score in relation to age variable. Young group: r = -0.04104 p = 0.4480 (ns); young adult group: r = 0.1168, ****p < 0.0001; adult group: r = 0.03169, p = 0.4045 (ns) and over 60 group: r = 0.1125, p = 0.0557 (ns) as determined by Spearman's ρ correlation. H.I,L. Correlation between total Δ-MET–min/week and total PGWBI score in high active, moderate active and low active participants. High group: r = 0.1322, ****p < 0.0001; moderate group: r = 0.1035, **p = 0.0020; low group: r = 0.08157 p = 0.0546 (ns) as determined by Spearman's ρ correlation.

4. Discussion

The worldwide spread of the SARS-CoV-2 infection led the Italian Government to apply unprecedented containment measures. The Decree of the Italian Prime Minister of March 20, 2020 has been issued to state an absolute ban to get away from their home, except to make essential work or activities. Quarantine has upset the normality of Italian daily life, forcing population to social distancing and self-isolation. The precautionary measures have also involved sport-related activities, including walking and running outside. Therefore, home workout remained the only possibility to play sports and stay active during Covid-19 pandemic. In the present work, we analyzed the total MET–min/wk before- and during COVID-19 quarantine and assess the relationship with the psychological well-being of 2524 participants, of which 41.76% was classified as a highly active group. Certainly, our study sample is very limited as compared to other work present in the current literature, such as the work by Jin and coauthors which included more than 500000 individuals, even if the treated topic was different [28]. To date, in Italy is not present a national health monitoring and surveillance system for physical activity, and no studies have collected large data showing the different activity levels of the general public [29]. However, data for the years 2010–2013 from the survey by the Italian Ministry of Health's Behavioural Risk Factor Surveillance System (Progressi delle Aziende Sanitarie per la Salute in Italia (PASSI)) [30], showed that 36% of Italian adults of 30–60 years and 24% of older adults of aged 60 + years meet the recommended physical activity levels. Moreover, in line with our results, a very recent study conducted on Sicilian population [31], showed that before COVID-19 quarantine, 44% and 50% of participants were moderate active and high active, respectively. Although the scientific community has highlighted the real benefits to stay active during the pandemic, our results showed a strong reduction of physical activity levels, especially for vigorous activity and walking. These data reflect the major difficulties to walk and perform an intense exercise at home, compared to moderate activity. The WHO recommends practising at least 150 min per week of moderate to vigorous-intensity physical activity or 75 min of high intensity per week, or a combination of both [29, 32]. Although running, fast swimming, playing basketball, soccer, represent vigorous-intensity activities burn more than 3000 MET–minutes/week, many other intense exercises can be performed staying at home, such as carrying/moving heavy load (>20 kg) or stair walking. Stairs can be found in most private homes, and stair climbing (at least 10 min per day) is considered a vigorous-intensity activity [33]. An opposite trend was found for subjects classified as low active before COVID-19, whose total physical activity energy expenditure during quarantine significantly increased. This phenomenon could be due to a radical change in everyday schedules and habits. People remaining at home spend much more time in low-intensity activities like housework (cooking, washing dishes or gardening). Another reason could be the greater female presence in the study that is generally more prone to do low-intensity activities. Our study also showed that during the pandemic, the physical activity levels significantly decreased in all age groups considered. Moreover, the male group showed highly significant variation between before and during COVID-19 emergency as compared to the female group. Previous works have largely indicated gender differences in exercise habits and motivations for exercise [34, 35, 36, 37]. Men practice physical activity mainly for social and competitive reasons. Moreover, they prefer to practice sports, outdoor and/or in public places like the gym and fitness clubs. Females are more inclined to exercise in home-setting, practising aerobics, dancing, yoga, pilates or circuits with push-ups, squats, planks and jumping jacks. Furthermore, the lower variation in physical activity levels between before and during quarantine found in women is possibly explained by the higher amount of housework physical activity than males [37, 38]. Secondly, we investigated the impact of physical activity on psychological well-being during the pandemic. Our results showed that the reduction of physical activity levels is ever related to the worse status of psychological well-being. The positive effects of regular physical activity on psychological health are indisputable in the field of modern medicine. Regular exercise improves one's self-esteem and a sense of well-being. Individuals who exercise regularly exhibit fewer depressive and anxiety symptoms, thus supporting the concept that physical activity provides a beneficial effect against the development of mental disorders [39]. Several studies have demonstrated that the anxiolytic effects of regular exercise are linked to change in hypothalamic-pituitary-adrenal (HPA) axis and mediation of the endogenous opioid system, which are involved in stress reactivity, anxiety, mood and emotional responses [40, 41, 42]. Furthermore, physical activity is implicated in the modulation of different trophic factors, such as brain-derived neurotrophic factor (BDNF). BDNF, whose levels are upregulated following exercise, represents the most abundant neurotrophin in the brain, which positively influences both anxiety and depressive disorders [43]. We found that the correlation between the reduction of physical activity and psychological well-being is stronger in the female group. Previous studies have examined gender differences between measures of physical fitness and life satisfaction, that is one of the central constructs in the field of positive psychology. Although most of them reflecting no difference between genders and life satisfaction, some works demonstrated higher life satisfaction measures among females when compared with males. This evidence suggests that reduction of physical activity levels may mostly influence mental well-being of female group [44, 45, 46, 47]. The current study also showed a significant correlation between the change in total activity and the PGWBI score in subjects classified as high active and moderate active as well as in the young adult group. The latter result is supported by previous studies demonstrating the strong relationship between physical activity and psychological well-being in this age group [47, 48, 49].

Although the negative impact on psychological well-being due to the reduction of physical activity levels is a dogma, currently in the literature there is only one study conducted in Canada that can strengthen our present results, regarding the worsen of psychophysical conditions during a period of forced rest due to a pandemic [50]. Generally, it is the individual to choose if perform or not physical activity, but the COVID-19 spread changed the world. Gyms, stadiums, pools, dance and fitness studios, physiotherapy centres, parks and playgrounds were closed, compelling people to find alternatives to exercise. Consequently, different life habits have been affected, with the modification of routines of mobility, physical activity, and habitual exercise protocols. Under such unusual conditions, barriers to keep an active life's style were hard to overcome. For the above reasons, we studied the impact of physical activity on psychological health during Covid-19 pandemic in Italy. The benefits of exercise are proven very helpful, especially in times of anxiety, crisis and fear. There are concerns therefore that, in the context of the pandemic, lack of access to regular sporting or exercise routines resulted in challenges to the immune system, physical health, including by leading to the commencement of or exacerbating existing diseases that have their roots in a sedentary lifestyle. Lack of access to exercise and physical activity had also mental health impacts, compound stress or anxiety that many experienced in the face of isolation from normal social life. Possible loss of family or friends from the virus and impact of the virus on one's economic well-being and access to nutrition exacerbated these effects.

The limitations of this study included the over-reporting bias of physical activity as well as to report at the same time point, information related to exercise levels before- and during COVID-19. However, IPAQ questionnaires may supply a reliable approximation of physical activity at a population level, and its validity has been confirmed in different studies [51, 52].

5. Conclusion

In conclusion, our results, for the first time in the literature, have shown that quarantine in Italy induces a significant reduction of total weekly physical activity energy expenditure in all age groups and especially in men, and this reduction negatively affects the psychological well-being.

In fact, physical activity has a profoundly positive impact on psychological health, by enhancing self-esteem and resilience to stress and reducing depression and anxiety. Given the spread of COVID-19, stay at home is a fundamental step to halt the pandemic. However, the clinical relevance of the present study denotes that maintaining regular physical activity is an important preventive strategy for physical and mental health during a forced rest period like the current coronavirus emergency. Then "stay active to feel better".

Declarations

Author contribution statement

G. Maugeri: Conceived and designed the experiments; Analyzed and interpreted the data; Wrote the paper.

P. Castrogiovanni, G. Battaglia, R. Pippi, V. D'Agata, M. Di Rosa: Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data.

A. Palma: Analyzed and interpreted the data; Wrote the paper.

G. Musumeci: Conceived and designed the experiments; Wrote the paper.

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Competing interest statement

The authors declare no conflict of interest.

Additional information

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