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How physical activity behavior affected well-being, anxiety and sleep quality during COVID-19 restrictions in Iran

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Abstract. – OBJECTIVE: The Islamic Republic of Iran has displayed one of the highest rates of COVID-19 infection in the world and the highest rate of mortality in the Middle East. Iran has used a stringent package of preventive health measures to mitigate the spread of infection, which however has negatively affected individuals' physical and psychological health. This study aimed at examining whether physical-activity (PA) behavior, anxiety, well-being, and sleep-quality changed in response to the COVID-19-related public health restrictions enforced in Iran.

PATIENTS AND METHODS: An online questionnaire was disseminated to adults residing in Iran from November 17, 2020, to February 13, 2021 (~88 days), during Iran's strictest public health restrictions. Main outcome measures included Godin-Shephard Leisure-Time Exercise Questionnaire, General Anxiety Disorder-7, Mental Health Continuum-Short Form, and Pittsburgh Sleep Quality Index.

RESULTS: A total of 3,323 adults (mean age 30±11 years, 54.3% female) participated in the survey. Firstly, the restrictions generally reduced PA behavior: (a) among inactive participants (IPs), 60.6% became less active *vs.* 5.1% who became more active; and (b) among active participants (APs), 49.9% became less active *vs.* 22.8% who became more active. Secondly, PA behavior was associated with higher well-being and sleep quality during the restrictions: (a) APs reported higher (or lower) levels of well-being and sleep quality (or anxiety) than did IPs; and (b) among IPs as well

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as among APs, the more active the participants, the greater (or lower) the levels of well-being and sleep quality (or anxiety).

CONCLUSIONS: This study showed the beneficial role of PA behavior for well-being, anxiety, and sleep quality during the COVID-19 restrictions, whereas such restrictions appeared to decrease PA participation. Active lifestyle should be then encouraged during the COVID-19 outbreak while taking precautions.

Key Words:
Coronavirus disease, Exercise, Lifestyle Behavior Change, Mental Health, Sedentary Behavior.

Introduction

The still ongoing "Coronavirus Disease 2019" (COVID-19) pandemic emerged in the late 2019 in Wuhan (Hubei Province, China), and has been transmitted to over 210 other countries/territories across the globe[1-5]. The Islamic Republic of Iran is among the most affected countries since the beginning of the COVID-19 outbreak[6,7]. Accordingly, Iran, as many other countries, has taken several public health measures, such as quarantine, isolation, travel restrictions, closure of most non-essential businesses (including leisure and sports centers), stay-at-home orders, and schools and universities closures. Such measures aimed at preventing or, at least, mitigating the burden imposed by the COVID-19 pandemic, as well as at delaying and curbing the spread of the virus[8]. It was reported that the resulting quarantine of the spread of the virus fostered sedentary behaviors and notably led to decrease physical-activity (PA) participation[1,2,9-13]. This led to higher levels of depression, anxiety and post-traumatic symptoms[14-19], as well as to lower levels of sleep quality[20,21].

Even though research identified a plethora of psychosocial risk factors for mental health (e.g., social isolation, economic uncertainty, job loss, concerns about the health of one's own children and extended family)[22,23], it also revealed protective factors, such as PA[24]. Physically active participants (APs) generally experience less stress, depression, and anxiety[25]. In recent years, PA has been suggested as a potential treatment for depression and anxiety alongside pharmacological strategies[26]. It was also suggested that PA could influence circadian rhythms, thus affecting sleep-quality[27,28]. The goals of the present article were to examine *(a)* whether COVID-19 restrictions can affect PA behavior in Iran, and *(b)* whether PA behavior can affect well-being, anxiety and sleep-quality during COVID-19 restrictions. This research may help guide future public health interventions. Based on the existing literature, it was hypothesised that: *(i)* COVID-19 restrictions would reduce PA behavior; and *(ii)* the more the participants take part in PA, the better their mental health and sleep-quality during COVID-19 restrictions.

Patients and Methods

Participants

In order to participate in the current study, participants had to be Iranian residents aged ≥ 18 years. Participants were recruited through snowball sampling using social media, including those who liked, commented on or subscribed to stories in national and local media to avoid the direct physical contact and prevent the spread of the virus through droplets or contact. Furthermore, personal Instagram, Telegram, and WhatsApp accounts of the Iranian authors and advertisement in various groups and channels were utilized. To encourage participants to take the survey, cash prizes by lottery were offered to the individuals.

The sample size was calculated according to the following formula[29]: ; where "n" was the number of needed individuals; "$Z_{\alpha/2}$" was the two-tailed normal deviate for type 1 error ($Z_{\alpha/2}$ = 3.29 for 99.9% level of significance); "q" was equal to "1- p"; "D" was the accuracy (=2.8%), and "p" was the percentage of change from "before" to "during" confinement period. The "p" was identified from a Canadian study[30] reporting that 40.5% (p=0.405) of inactive participants (IPs) became less active. The sample size was therefore 3,327 consecutive participants.

Participants did not have to mention their names or contact information, except for those who desired to participate in the draw cash prizes. In addition, participants could stop participating in the study and withdraw from the investigation at any time. They could leave the questionnaire at any stage before the submission process without saving their responses. By completing the survey and clicking on the "submit" button, individual's responses were saved, and they were consenting

to participate in this anonymous study voluntarily. This study was conducted following the Declaration of Helsinki and received approval from the Institute of Physical Education and Sports Sciences (Tehran, Iran) Human Subject Committee (IR.SSRC.REC.1400.034).

Measures

Participants completed the Persian version of an online survey software (PORSA questionnaire maker) from November 17, 2020, to February 13, 2021 (~88 days), during Iran's strictest public health restrictions (https://www.who.int/news-room/feature-stories/detail/in-middle-east-covid-19-hotspot-iran-who-walks-the-talk, last visit: August 17, 2021). All participants reported their demographic data and completed four standardized questionnaires: PA behavior, anxiety, well-being, and sleep-quality.

Demographic Information

Demographic characteristics included age, sex, marital status, schooling-level (*i.e.*, high school, diploma, associate, bachelor, master, doctoral), occupational status before COVID-19 (*i.e.*, full-time, part-time, unemployed, homemaker, retired, unable to work) and its changes due to COVID-19 (*i.e.*, no change, decreased hours, remote work, laid off, employed, increased hours), living environment (*i.e.*, urban, suburban, rural), and living-location according to the geographical division of the provinces of Iran (*i.e.*, central, northern, southern, eastern, western).

PA Behavior

We used the Persian version of the Godin-Shephard Leisure-Time Exercise Questionnaire (GSLTEQ) to assess individual PA behavior over the previous week[31]. This questionnaire has been previously administered to Iranian populations and found to have an acceptable reliability (reliability coefficient = 0.79)[31]. Participants report the frequency of participation in more than 15 minutes of mild, moderate, and strenuous PA. Then, the frequency of PA, depending on the intensity, is multiplied by a pre-defined coefficient (relevant metabolic equivalents or METs): mild (3), moderate (5), and strenuous (9). The sum of the numbers obtained is the resulting score of the GSLTEQ: > 24 (active), 14-23 (moderately active), and < 14 (insufficiently active/sedentary)[32]. We divided individuals according to their GSLTEQ score: ≥ 24 (active), ≤ 23 (inactive)[33].

We also asked further questions to assess current PA behavior: whether PA had changed (less, about the same, or more) since restriction onset, the type of PA most frequently participated in (no activity, weight training, biking/cycling, walking, running, martial, online videos/classes, other), whether the type of PA had changed since restriction onset (very similar, somewhat similar, not so similar), location of PA (outdoors, indoors, in the home), and whether the location had changed due to social distancing measures (yes/no).

Anxiety

We used the Persian version of General Anxiety Disorder-7 (GAD-7) to assess individual anxiety symptoms[34]. The GAD-7 has been previously used with Iranians and found to have good reliability (Cronbach's alpha = 0.876)[34]. Seven items assess the frequency of anxiety symptoms over the past two weeks on a 4-point Likert scale: 0 (not at all), 1 (several days), 2 (more than half the days), and 3 (nearly every day). After adding up the scores, the total score of GAD-7 ranges from 0 to 21, with increasing scores indicating more severe functional impairments as a result of anxiety: 0-4 (no anxiety), 5-9 (mild anxiety), 10-14 (moderate anxiety), and 15-21 (severe anxiety)[35].

Well-Being

We used the Persian version of the Mental Health Continuum-Short Form (MHC-SF) to assess overall well-being and emotional, psychological, and social well-being[36]. The MHC-SF has been previously used with Iranians and found to have excellent reliability for emotional, social, and psychological subscales and total score on the MHC-SF (Cronbach's alpha = 0.84, 0.88, 0.88, and 0.92, respectively)[36]. The MHC-SF is a self-rating assessment tool comprised of 14 items: 1-3 (emotional well-being), 4-8 (social well-being), and 9-14 (psychological well-being), that assess the frequency of feelings over the past month on a 6-point Likert-scale: 0 (never), 1 (once or twice), 2 (about once a week), (3) about two to three times a week, (4) almost every day, and (5) every day. Therefore, the total resulting score can range from 0 to 70. A higher score means a higher level of well-being[37]. Besides, the total scale is also used to classify individuals as flourishing (>56) or languishing (14-28).

Sleep-Quality

We used the Persian version of the Pittsburgh Sleep Quality Index (PSQI) to assess individual's sleep-quality over the past month[38]. The PSQI has been previously used with Iranian populations

and found to have good reliability (Cronbach's alpha = 0.81)[38]. The PSQI scale contains 19 self-rated questions, and seven components: subjective sleep-quality, sleep-latency, sleep-duration, habitual sleep-efficiency, sleep-disturbance, use of sleeping medication, and daytime dysfunction. The score of each component is weighted equally on a 0-3 scale. The global PSQI score ranges from 0 to 21, with higher scores indicating more severe sleep disorder: "0" (no trouble) and "21" (severe problems in all components). The global PSQI score > 5 is indicative of poor sleep[39].

We also asked further questions to assess current sleep-quality: *(i)* whether sleep habits had changed since restriction onset (same, I sleep earlier, I sleep later), *(ii)* whether the time of the sleep had changed (same, more, less), *(iii)* whether the amount of sleep had changed since restriction onset, and *(iv)* If sleep habits changed, are they satisfied with it (not changed, satisfied, not satisfied).

Statistical Analysis

Demographic characteristics were present by sex and summarized using descriptive statistics. Independent *t*-tests and chi-square test were utilized to compare demographic differences between both groups. To analyze PA behavior, well-being, and sleep-quality outcomes, individuals were split into IPs and APs, and comparative analysis was conducted utilizing *t*-tests and chi-square test. To further explore differences within the active and inactive groups, and well-being and sleep-quality outcomes, participants were further categorized based on self-reported changes in PA behavior (less active, similar active, more active due to COVID-19 restrictions). One-way ANOVA and Tukey post-hoc tests were thus conducted to explore differences within subgroups. Finally, independent sample *t*-test and one-way ANOVA were conducted to assess differences between APs and IPs and well-being and sleep-quality measures. Data analysis was completed using the software Statistical Package for Social Sciences (SPSS-26.0 software, Armonk, NY, USA), and significance threshold was set at $p < 0.05$.

Results

We got 3,519 replies. After excluding individuals who did not answer all questions, data of 3,323 individuals were considered for the analysis.

Table I lists individual demographics categorized by sex. Most of participants were female (54.3%), single (60.2%), and had bachelor's or master's degrees (58.1%). While many participants reported that they were unemployed (34.6%), most participants indicated that they had experienced no change in their employment status because of COVID-19 (63.7%). Most participants were currently living in Iran's Central provinces (38.5%). Most individuals (88.8%) lived in urban areas.

Changes in PA Engagement

Table II summarizes the PA behaviors and characteristics between the APs and IPs. There was a significant ($p < 0.001$) difference between APs and IPs regarding PA change due to COVID-19 restrictions. 60.6% of IPs became even less active, while only 49.9% of APs became less active ($p < 0.001$). Comparatively, 5.1% of IPs became more active, while 22.8% of APs became more active. The majority of the IPs participated in walking (36.1%) or had no activity (34%).

The most commonly reported activities for the APs included walking (37.4%), other activities (22.1%), and resistance (weight) training (13.2%). Since COVID-19 restrictions were in place, 38.4% of IPs altered their PA type. In comparison, 34.1% of APs altered their typical PA choice. The majority (87.8%) of individuals participated in PA either in the house or outdoors, with 53.6% of the inactive population compared to 47.4% of the active population participated in PA in the house environment. The PA location of the majority of the IPs (59.8%) was the same. In comparison, the restrictions changed the PA location of the majority of APs (59.8%).

Well-Being and Anxiety Scores Based on PA Changes

IPs scored significantly lower ($p < 0.001$) on the overall well-being than APs (Mean±SD, 44.83±15.43 and 50.27±15.20, respectively) (Table III). Besides, emotional ($p < 0.001$), psychological ($p < 0.001$), and social well-being ($p < 0.001$) of APs was significantly higher than the IPs. Also, anxiety scores of APs was significantly lower ($p < 0.001$) than IPs (Mean±SD, 6.80±4.80, 8.14±5.30, respectively) (Table III). Anxiety was less severe in APs.

Sleep-Quality Scores Based on Changes in PA

IPs scored significantly lower ($p < 0.001$) on the global score of sleep-quality than APs (Mean±SD, 6.04±2.95, 5.59±2.94, respectively). Also, among the factors related to sleep-quality, only a significant relationship was found between subjective sleep-quality and sleep-latency

Table I. Individual demographics categorized by sex†.

Characteristics		Male N (%) 1517 (45.7)	Female N (%) 1806 (54.3)	Total N (%) 3323 (100)	*p*-value
Age	Mean ± SD	31 ± 11	28 ± 11	30 ± 11	<0.001
Marital status	Single	867 (57.2)	1133 (62.7)	2000 (60.2)	0.001
	Married	650 (42.8)	673 (37.3)	1323 (39.8)	
Schooling-level	High school	80 (5.3)	198 (11.0)	278 (8.4)	< 0.001
	Diploma	327 (21.6)	438 (24.3)	765 (23.0)	
	Associate	94 (6.2)	104 (5.8)	198 (6.0)	
	Bachelor	605 (39.9)	689 (38.2)	1294 (38.9)	
	Master	329 (21.7)	308 (17.1)	637 (19.2)	
	Doctoral	82 (5.4)	69 (3.8)	151 (4.5)	
Employment status (pre-COVID-19)	Full-time	708 (46.7)	352 (19.5)	1060 (31.9)	< 0.001
	Part-time	345 (22.7)	350 (19.4)	695 (20.9)	
	Unemployed	395 (26.0)	754 (41.7)	1149 (34.6)	
	Homemaker	1 (0.1)	272 (15.1)	273 (8.2)	
	Retired	65 (4.3)	68 (3.8)	133 (4.0)	
	Unable to work	3 (0.2)	10 (0.6)	13 (0.4)	
Employment status (post-COVID-19)	No change	891 (58/7)	1226 (67.9)	2117 (63.7)	< 0.001
	Decreased hours	230 (15.2)	117 (6.5)	347 (10.4)	
	Remote work	148 (9.8)	189 (10.5)	337 (10.1)	
	Laid off	168 (11.1)	172 (9.5)	340 (10.2)	
	Employed	36 (2.4)	49 (2.7)	85 (2.6)	
	Increased hours	44 (2.9)	53 (2.9)	97 (2.9)	
Environment	Urban	1347 (88.8)	1604 (88.8)	2951 (88.8)	0.167
	Suburban	70 (4.6)	103 (5.7)	173 (5.2)	
	Rural	100 (6.6)	99 (5.5)	199 (6.0)	
Location	Central	616 (40.6)	662 (36.7)	1278 (38.5)	0.005
	Northern	266 (17.5)	307 (17.0)	573 (17.2)	
	Southern	178 (11.7)	195 (10.8)	373 (11.2)	
	Eastern	186 (12.3)	298 (16.5)	484 (14.6)	
	Western	271 (17.9)	344 (19.0)	615 (18.5)	

between APs and IPs. There were no significant differences in the global sleep-quality score in the inactive subgroups. On the other hand, in the active population, significant differences were seen in sleep-quality scores among subgroups (p = 0.003) (Table IV). The APs that maintained their activity levels had better sleep-quality.

Additional questions about sleep-quality after COVID-19 showed that sleep-habits of 49.3% of individuals (APs= 49.5% and IPs= 49.1%) had changed, so that 39.8% of them slept later; sleep time of 44.6% of individuals (APs= 43.7% and IPs= 45.5%) had changed, so that 28.7% of them slept more; and a significant portion of them (APs= 36.7% and IPs= 42.2%) were dissatisfied with their sleep-habit changes. Only 16.2% of the individuals, whose sleep-habits were changed, were satisfied with the altered sleep patterns.

Discussion

The present study examined the impact of COVID-19 restrictions on PA behavior, as well as whether PA behavior could affect well-being, anxiety, and sleep-quality during such restrictions in Iranian populations. Our results showed that most APs and IPs became less active during COVID-19 restrictions, even though a portion of APs became more active during the outbreak. As expected, APs had higher well-being, lower anxiety levels, and better sleep quality than did the IPs.

The present data suggest that COVID-19 restrictions significantly influenced PA behaviors in Iranians. A previous report[40] from Iran showed that COVID-19 had significantly decreased PA level of Qom residents, but this report is unique to the city of Qom and does not represent all the

Table II. Physical-activity (PA) behaviors.

Characteristics		Inactive N (%) 1728 (52.0)	Active N (%) 1595 (48.0)	Total N (%) 3323 (100)	*p*-value
Change in PA	Less	1047 (60.6)	796 (49.9)	1843 (55.5)	< 0.001
	About the same	593 (34.3)	435 (27.3)	1028 (30.9)	
	More	88 (5.1)	364 (22.8)	452 (13.6)	
The most common type of PA	No activity	587 (34.0)	57 (3.6)	644 (19.4)	< 0.001
	Weight training	90 (5.2)	211 (13.2)	301 (9.1)	
	Biking/cycling	36 (2.1)	79 (5.0)	115 (3.5)	
	Walking	624 (36.1)	596 (37.4)	1220 (36.7)	
	Running	70 (4.1)	163 (10.2)	233 (7.0)	
	Martial	18 (1.0)	53 (3.3)	71 (2.1)	
	Online videos/classes	35 (2.0)	84 (5.3)	119 (3.6)	
	Other	268 (15.5)	352 (22.1)	620 (18.7)	
Change in type of PA	Very similar	761 (44.0)	514 (32.2)	1275 (38.4)	< 0.001
	Somewhat similar	304 (17.6)	537 (33.7)	841 (25.3)	
	Not so similar	663 (38.4)	544 (34.1)	1207 (36.3)	
Most common PA location	Outdoors	609 (35.2)	628 (39.4)	1237 (37.2)	< 0.001
	Indoors	192 (11.1)	211 (13.2)	403 (12.1)	
	In the house	927 (53.6)	756 (47.4)	1683 (50.6)	
Change in PA location	Yes	929 (53.8)	954 (59.8)	1883 (56.7)	< 0.001
	No	954 (59.8)	641 (40.2)	1440 (43.3)	

geographical locations of Iran. To the best of the authors' knowledge, this is the first study to examine the relationships between PA behavior, anxiety, well-being, and sleep quality in Iranian populations and in Middle East in the context of COVID-19 pandemic and associated restrictions.

Surveys from other countries also corroborate our finding that most people decreased their PA since COVID-19 restrictions[41]. The current findings also align with recent systematic review[42] reporting the negative impact of COVID-19 restrictions on PA level during the first wave of COVID-19 in the general population. This negative impact of PA could be probably explained by several factors, such as social support, professional assistance, availability of equipment and trans-

Table III. Well-being and anxiety.

Factors	Inactive (n = 1728)				Active (n = 1595)			
	Less Active (n = 1047)	Similar active (n = 593)	More active (n = 88)	*p*-value	Less active (n = 796)	Similar active (n = 435)	More active (n = 364)	*p*-value
Emotional well-being	10.26±3.83*	10.17±3.97*	11.52±3.99	0.009	11.13±3.86*	11.59±3.85*	12.22±3.56	< 0.001
Psychological well-being	17.14±6.52	16.74±6.63	17.48±6.91	0.390	18.70±6.39	19.11±7.14	19.66±6.65	0.076
Social well-being	17.74±6.62	17.06±6.89	17.85±7.02	0.124	19.31±6.45*	19.95±6.65*	20.42±5.99	0.017
Overall well-being	45.15±15.18	43.96±15.73	46.85±16.25	0.149	49.14±14.87*	50.64±16.16*	52.29±14.51	0.004
General Anxiety Disorder-7	8.31±5.25	8.02±5.36	7.01±5.30	0.068	7.49±4.84 #*	6.06±4.88	6.17±4.37	< 0.001

Data expressed as means ± standard deviation. *Significant difference in comparison with the more active group, $p<0.05$. #Significant difference in comparison with the similar active group, $p < 0.05$.

Table IV. The Pittsburgh Sleep Quality Index (PSQI) outcomes about changes in physical-activity since COVID-19.

Factors		Inactive (n = 1728)				Active (n = 1595)			
		Less Active N (%) 1047 (60.6)	Similar active N (%) 593 (34.3)	More active N (%) 88 (5.1)	*p*-value	Less Active N (%) 796 (49.9)	Similar active N (%) 435 (27.3)	More active N (%) 364 (22.8)	*p*-value
Subjective sleep-quality	Very good	174 (16.6)	95 (16.0)	16 (18.2)	0.429	136 (17.1)	111 (25.5)	78 (21.4)	0.004
	Fairly good	558 (53.3)	346 (58.3)	52 (59.1)		460 (57.8)	247 (56.8)	216 (59.3)	
	Fairly bad	238 (22.7)	113 (19.1)	15 (17.0)		146 (18.3)	55 (12.6)	53 (14.6)	
	Very bad	77 (7.4)	39 (6.6)	5 (5.7)		54 (6.8)	22 (5.1)	17 (4.7)	
Sleep-latency	Very good	157 (15.0)	86 (14.5)	12 (13.6)	0.305	124 (15.6)	79 (18.2)	53 (14.6)	0.054
	Fairly good	313 (29.9)	195 (32.9)	32 (36.4)		251 (31.6)	162 (37.2)	114 (31.3)	
	Fairly bad	272 (26.0)	134 (22.6)	14 (15.9)		202 (25.4)	103 (23.7)	107 (29.4)	
	Very bad	305 (29.1)	178 (30.0)	30 (34.1)		218 (27.4)	91 (20.9)	90 (24.7)	
Sleep-duration	Very good	681 (65.0)	373 (62.9)	57 (64.8)	0.447	530 (66.6)	305 (70.1)	247 (67.9)	0.533
	Fairly good	227 (21.7)	127 (21.4)	24 (27.3)		159 (20.0)	71 (16.3)	70 (19.2)	
	Fairly bad	88 (8.4)	62 (10.5)	5 (5.7)		67 (8.4)	34 (7.8)	34 (9.3)	
	Very bad	51 (4.9)	31 (5.2)	2 (2.3)		40 (5.0)	25 (5.7)	13 (3.6)	
Habitual sleep-efficacy	Very good	1014 (96.9)	568 (96.1)	86 (97.7)	0.553	778 (97.7)	409 (94.2)	353 (97.2)	0.029
	Fairly good	23 (2.2)	14 (2.4)	2 (2.3)		11 (1.4)	18 (4.1)	5 (1.4)	
	Fairly bad	6 (0.6)	3 (0.5)	0 (0.0)		2 (0.3)	3 (0.7)	1 (0.3)	
	Very bad	3 (0.3)	6 (1.0)	0 (0.0)		5 (0.6)	4 (0.9)	4 (1.1)	
Sleep-disturbances	Very good	74 (7.1)	36 (6.1)	9 (10.2)	0.236	46 (5.8)	41 (9.4)	13 (3.6)	0.011
	Fairly good	679 (64.9)	412 (69.5)	60 (68.2)		545 (68.5)	249 (67.6)	274 (75.3)	
	Fairly bad	271 (25.9)	128 (21.6)	18 (20.5)		188 (23.6)	93 (21.4)	69 (19.0)	
	Very bad	23 (2.2)	17 (2.9)	1 (1.1)		17 (2.1)	7 (1.6)	8 (2.2)	
Use of sleeping medicine	Very good	909 (86.8)	533 (89.9)	82 (93.2)	0.024	703 (88.3)	393 (90.3)	341 (93.7)	0.105
	Fairly good	69 (6.6)	19 (3.2)	3 (3.4)		43 (5.4)	15 (3.4)	11 (3.0)	
	Fairly bad	23 (2.2)	21 (3.5)	1 (1.1)		26 (3.3)	13 (3.0)	4 (1.1)	
	Very bad	46 (4.4)	20 (3.4)	2 (2.3)		24 (3.0)	14 (3.2)	8 (2.2)	
Daytime dysfunction	Very good	229 (28.6)	192 (32.4)	28 (31.8)	0.605	268 (33.7)	175 (40.2)	128 (35.2)	0.060
	Fairly good	369 (35.2)	212 (35.8)	28 (31.8)		290 (36.4)	158 (36.3)	137 (37.6)	
	Fairly bad	276 (26.4)	140 (23.6)	24 (27.3)		172 (21.6)	76 (17.5)	82 (22.5)	
	Very bad	103 (9.8)	49 (8.3)	8 (9.1)		66 (8.3)	26 (6.0)	14 (4.7)	
Global score	means ±SD	6.11±3.00	5.97±2.88	5.67±2.71	0.302	5.83±3.00*#	5.25±3.02	5.50±2.66	0.003

PSQI: Pittsburgh Sleep Quality Index; DS: deviation standard.* Global scores expressed as means ± standard deviation. Significant difference in comparison with the more active group, $p<0.05$. #Significant difference in comparison with the similar active group, $p<0.05$.

portation, and the severity of lockdowns restrictions[43,44]. A Canadian study[30] reported that 40.5% of IPs and 22.4% of APs were engaged in less PA since the restrictions, while 33% of IPs and 40.3% of APs increased PA levels after the restrictions. There is a general consensus among the scientific community that PA improves physical and mental health, reduces the mortality risk for older adults and individuals with comorbid conditions, and counteracts the harmful effects of short and chronic periods of physical inactivity[1,10,43,45-47].

The present study highlighted that IPs had higher anxiety levels than did APs. In addition, APs who decreased their PA levels had higher anxiety levels than did APs who increased or maintained similar PA levels. In addition, we found that IPs with mild anxiety were more physically active than were individuals with moderate anxiety. In line with previous studies, physical inactivity and reduced PA levels are associated with increased levels of anxiety during COVID-19 pandemic in Canada[30,48], Brazil[49,50], France and Switzerland[51], which could increase cardiovascular disease risk[52]. A similar Canadian study[30] explored the anxiety levels in APs and IPs and their subgroups (less

active, similar active, more active) showing a non-significant difference between anxiety levels of APs and IPs. They also found that increased or maintained PA in IPs was associated with lower anxiety than those who decreased their PA levels[30].

The present data showed that all four measured scores of well-being of APs had higher well-being than IPs. Also, the emotional well-being of IPs who increased their PA was higher than the other two subgroups (less or similar PA). These findings highlight the importance of promoting PA to overcome the psychological problems including anxiety and depressive symptoms associated with COVID-19 pandemic. In line with our findings, it has been shown that COVID-19 outbreak led to a mental health crisis in people residing in Iran[53], Canada[30], United Kingdom, Ireland, New Zealand and Australia[54].

The data related sleep-quality showed that APs had better sleep-quality than did the IPs. We also found that APs who decreased their PA had poorer sleep-quality than did the other two subgroups. It has been shown that the COVID-19 outbreak increased poor sleep-quality worldwide[55,56]. As mentioned above, the COVID-19 outbreak by itself can decrease PA, mental health, and sleep-quality, as well as increase anxiety levels. It has been also shown that poor sleep-quality is associated with high level of poor psychological well-being[57] as well as anxiety disorders[58]. Anxiety disorders are associated with lower mental health-related quality of life and, when accompanied with poor sleep-quality, the negative impact on mental health becomes even greater[58]. Poor sleep-quality can also lead to reduced PA levels[59], and a strong positive correlation has been shown between PA and mental health[60]. Thus, mental health, anxiety, and sleep-quality are inter-related, and the combination can make them synergistic.

On the other hand, it has been shown that PA and sleep have substantial positive effects on one another[61], with PA having a substantial positive effect on mental health[60] and is associated with lower anxiety[62]. According to previous studies, we propose that PA is a key strategy to combat the negative effects of COVID-19 outbreak on sleep-quality, anxiety, and mental health. Additionally, PA levels more so than some other factors is affected with COVID-19 outbreak and changes in PA levels had a profound effect on the health-related factors (mental health, sleep-quality, and anxiety).

The main strength of this study was the large-scale sample size. However, our study is not without limitations. Given that our study was conducted in the middle of the COVID-19 outbreak without of pre-COVID data about anxiety, mental health, and sleep-quality, we cannot explore potential changes in these factors. In addition, the web-based voluntary approach of our study would result in selection bias.

Conclusions

COVID-19 restrictions affected Iranian and were associated with negative effects in terms of PA behavior, anxiety, mental-health, and sleep-quality. These findings have substantial implications for policy and guideline recommendations to encourage individuals to be physically active, and thus promote lower anxiety level and better mental health, well-being, and sleep-quality among individuals throughout the ongoing COVID-19 outbreak and the subsequent recovery period. Active lifestyle must be encouraged during the COVID-19 outbreak while taking precautions.

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Conflict of Interest
The authors declare no conflict of interest.

References

1) Ghram A, Briki W, Mansoor H, Al-Mohannadi AS, Lavie CJ, Chamari K. Home-based exercise can be beneficial for counteracting sedentary behavior and physical inactivity during the COVID-19 pandemic in older adults. Postgrad Med 2020: 1-12.
2) Ghram A, Bragazzi NL, Briki W, Jenab Y, Khaled M, Haddad M, Chamari K. COVID-19 Pandemic and Physical Exercise: Lessons Learnt for Confined Communities. Front Psychol 2021; 12: 618585.
3) Dhama K, Khan S, Tiwari R, Sircar S, Bhat S, Malik YS, Singh KP, Chaicumpa W, Bonilla-Aldana DK, Rodriguez-Morales AJ . Coronavirus Disease 2019-COVID-19. Clin Microbiol Rev 2020; 33: e00028-20.
4) Chen J, Ye L, Zhou MY, Cheng YR, Wang MW, Feng ZH. Herd immunity and COVID-19. Eur Rev Med Pharmacol Sci 2020; 24: 4064-4065.
5) Lee IR, Kim HW, Lee Y, Koyanagi A, Jacob L, An S, Shin JI, Smith L . Changes in undergraduate medical education due to COVID-19: a systematic review. Eur Rev Med Pharmacol Sci 2021; 25: 4426-4434.

6) Raoofi A, Takian A, Akbari Sari A, Olyaeemanesh A, Haghighi H, Aarabi M. COVID-19 Pandemic and Comparative Health Policy Learning in Iran. Arch Iran Med 2020; 23: 220-234.
7) Prajapati S, Sharma M, Kumar A, Gupta P, Narasimha Kumar GV. An update on novel COVID-19 pandemic: a battle between humans and virus. Eur Rev Med Pharmacol Sci 2020; 24: 5819-5829.
8) Blandenier E, Habibi Z, Kousi T, Sestito P, Flahault A, Rozanova L. Initial COVID-19 Outbreak: An Epidemiological and Socioeconomic Case Review of Iran. Int J Environ Res Public Health 2020; 17: 9593.
9) Hall G, Laddu DR, Phillips SA, Lavie CJ, Arena R. A tale of two pandemics: How will COVID-19 and global trends in physical inactivity and sedentary behavior affect one another? Prog Cardiovasc Dis 2021; 64: 108-110.
10) Jiménez-Pavón D, Carbonell-Baeza A, Lavie CJ. Physical exercise as therapy to fight against the mental and physical consequences of COVID-19 quarantine: Special focus in older people. Prog Cardiovasc Dis 2020; 63: 386-388.
11) Ghram A, Ben Saad H, Briki W, Jiménez-Pavón D, Mansoor H, Moalla W, Akbari HA, Ghram A, Al-Mohannadi AS, Arena R, Lavie CJ. Ramadan Intermittent Fasting, Physical Activity, and COVID-19 Pandemic in Patients with Chronic Diseases. Am J Med 2021; 134: 1189-1191.
12) Ghram A, Moalla W, Lavie CJ. Vaccine and physical activity in the era of COVID-19 pandemic. Prog Cardiovasc Dis 2021; 67: 33-34.
13) Haddad M, Abbes Z, Ghram A, Cosma G, Chamari K. Chapter 13 - Physical activity as a counteracting measure to mitigate the harmful effects of COVID-19 lockdowns: Special focus on healthy children, adolescents, adults, elderly, athletes, and people with Down syndrome. ed. Mental Health Effects of COVID-19: Academic Press 2021: 215-234.
14) Brooks SK, Webster RK, Smith LE, Woodland L, Wessely S, Greenberg N, Rubin GJ. The psychological impact of quarantine and how to reduce it: rapid review of the evidence. Lancet 2020; 395: 912-920.
15) 15. Santabárbara J, Lasheras I, Lipnicki DM, Bueno-Notivol J, Pérez-Moreno M, López-Antón R, De la Cámara C, Lobo A, Gracia-García P. Prevalence of anxiety in the COVID-19 pandemic: An updated meta-analysis of community-based studies. Prog Neuropsychopharmacol Biol Psychiatry 2021; 109: 110207.
16) Paz C, Mascialino G, Adana-Díaz L, Rodríguez-Lorenzana A, Simbaña-Rivera K, Gómez-Barreno L, Troya M, Paez MI, Cárdenas J, Gerstner RM, Ortiz-Prado E. Behavioral and sociodemographic predictors of anxiety and depression in patients under epidemiological surveillance for COVID-19 in Ecuador. PLoS One 2020; 15: e0240008.
17) Guo Y, Cheng C, Zeng Y, Li Y, Zhu M, Yang W, Xu H, Li X, Leng J, Monroe-Wise A, Wu S. Mental Health Disorders and Associated Risk Factors in Quarantined Adults During the COVID-19 Outbreak in China: Cross-Sectional Study. J Med Internet Res 2020; 22: e20328.
18) Dubey S, Biswas P, Ghosh R, Chatterjee S, Dubey MJ, Chatterjee S, Lahiri D, Lavie CJ. Psychosocial impact of COVID-19. Diabetes Metab Syndr 2020; 14: 779-88.
19) Sun P, Fan DJ, He T, Li HZ, Wang G, Zhang XZ, Wu YQ, Dai YH. The effects of psychological intervention on anxiety symptoms of COVID19-positive patients isolated in hospital wards. Eur Rev Med Pharmacol Sci 2021; 25: 498-502.
20) Morin CM, Carrier J, Bastien C, Godbout R; Canadian Sleep and Circadian Network. Sleep and circadian rhythm in response to the COVID-19 pandemic. Can J Public Health 2020; 111: 654-657.
21) Sher L. COVID-19, anxiety, sleep disturbances and suicide. Sleep Med 2020; 70: 124.
22) Browning MHEM, Larson LR, Sharaievska I, Rigolon A, McAnirlin O, Mullenbach L, Cloutier S, Vu TM, Thomsen J, Reigner N, Metcalf EC, D'Antonio A, Helbich M, Bratman GN, Alvarez HO. Psychological impacts from COVID-19 among university students: Risk factors across seven states in the United States. PLoS One 2021; 16: e0245327.
23) Pfefferbaum B, North CS. Mental Health and the Covid-19 Pandemic. N Engl J Med 2020; 383: 510-512.
24) White RL, Babic MJ, Parker PD, Lubans DR, Astell-Burt T, Lonsdale C. Domain-specific physical activity and mental health: a meta-analysis. Am J Prev Med 2017; 52: 653-666.
25) Chekroud SR, Gueorguieva R, Zheutlin AB, Aulus M, Krumholz HM, Krystal JH, Chekroud AM. Association between physical exercise and mental health in 1· 2 million individuals in the USA between 2011 and 2015: a cross-sectional study. Lancet Psychiatry 2018; 5: 739-746.
26) Carek PJ, Laibstain SE, Carek SM. Exercise for the treatment of depression and anxiety. The international journal of psychiatry in medicine 2011; 41: 15-28.
27) Youngstedt SD, Elliott JA, Kripke DF. Human circadian phase–response curves for exercise. J Physiol 2019; 597: 2253-2268.
28) Lowe H, Haddock G, Mulligan LD, Gregg L, Fuzellier-Hart A, Carter LA, Kyle SD et al. Does exercise improve sleep for adults with insomnia? A systematic review with quality appraisal. Clin Psychol Rev 2019; 68: 1-12.
29) Whitley E, Ball J. Statistics review 4: sample size calculations. Crit Care 2002; 6: 335-341.
30) Lesser IA, Nienhuis CP. The Impact of COVID-19 on Physical Activity Behavior and Well-Being of Canadians. Int J Environ Res Public Health 2020; 17: 3899
31) Farmanbar R, Niknami S, Lubans DR, Hidarnia A. Predicting exercise behaviour in Iranian college students: Utility of an integrated model of health behaviour based on the transtheoretical model and self-determination theory. Health Educ J 2013; 72: 56-69.
32) Godin G, Shephard RJ. A simple method to assess exercise behavior in the community. Can J Appl Sport Sci 1985; 10: 141-146.
33) Amireault S, Godin G. The Godin-Shephard leisure-time physical activity questionnaire: validity

evidence supporting its use for classifying healthy adults into active and insufficiently active categories. Percept Mot Skills 2015; 120: 604-622.
34) Omani-Samani R, Maroufizadeh S, Ghaheri A, Navid B. Generalized anxiety Disorder-7 (GAD-7) in people with infertility: a reliability and validity study. Middle East Fertil Soc J 2018; 23: 446-449.
35) Fu W, Wang C, Zou L, Guo Y, Lu Z, Yan S, Mao J. Psychological health, sleep quality, and coping styles to stress facing the COVID-19 in Wuhan, China. Transl Psychiatry 2020; 10: 225.
36) Rafiey H, Alipour F, LeBeau R, Amini Rarani M, Salimi Y, Ahmadi S. Evaluating the psychometric properties of the Mental Health Continuum-Short Form (MHC-SF) in Iranian earthquake survivors. Int J Ment Health 2017; 46: 243-251.
37) Keyes CL. Mental illness and/or mental health? Investigating axioms of the complete state model of health. J Consult Clin Psychol 2005; 73: 539-548.
38) Chehri A, Nourozi M, Eskandari S, Khazaie H, Hemati N, Jalali A. Validation of the Persian version of the Pittsburgh Sleep Quality Index in elderly population. Sleep Sci 2020; 13: 119-124.
39) Buysse DJ, Reynolds III CF, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. Psychiatry Res 1989; 28: 193-213.
40) Amini H, Isanejad A, Chamani N, Movahedi-Fard F, Salimi F, Moezi M, Habibi S. Physical activity during COVID-19 pandemic in the Iranian population: A brief report. Heliyon 2020; 6: e05411.
41) Caputo EL, Reichert FF. Studies of physical activity and COVID-19 during the pandemic: a scoping review. J Phys Act Health 2020; 17: 1275-1284
42) Stockwell S, Trott M, Tully M, Shin J, Barnett Y, Butler L, McDermott D, Schuch F, Smith L. Changes in physical activity and sedentary behaviours from before to during the COVID-19 pandemic lockdown: a systematic review. BMJ Open Sport Exerc Med 2021; 7: e000960.
43) de Boer DR, Hoekstra F, Huetink KIM, Hoekstra T, Krops LA, Hettinga FJ et al. Physical Activity, Sedentary Behavior and Well-Being of Adults with Physical Disabilities and/or Chronic Diseases during the First Wave of the COVID-19 Pandemic: A Rapid Review. Int J Environ Res Public Health 2021; 18: 6342.
44) Martin Ginis KA, Ma JK, Latimer-Cheung AE, Rimmer JH. A systematic review of review articles addressing factors related to physical activity participation among children and adults with physical disabilities. Health Psychol Rev 2016; 10: 478-494.
45) Laddu DR, Lavie CJ, Phillips SA, Arena R. Physical activity for immunity protection: Inoculating populations with healthy living medicine in preparation for the next pandemic. Prog Cardiovasc Dis 2021; 64: 102-104.
46) Lavie CJ, Lee DC, Sui X, Arena R, O'Keefe JH, Church TS, Milani RV, Blair SN. Effects of Running on Chronic Diseases and Cardiovascular and All-Cause Mortality. Mayo Clin Proc 2015; 90: 1541-1552.
47) Sallis R, Young DR, Tartof SY, Sallis JF, Sall J, Li Q, Smith GN, Cohen DA. Physical inactivity is associated with a higher risk for severe COVID-19 outcomes: a study in 48 440 adult patients. Br J Sports Med 2021; 55: 1099-1105.
48) Petersen JA, Naish C, Ghoneim D, Cabaj JL, Doyle-Baker PK, McCormack GR. Impact of the COVID-19 Pandemic on Physical Activity and Sedentary Behaviour: A Qualitative Study in a Canadian City. Int J Environ Res Public Health 2021; 18: 4441.
49) Puccinelli PJ, da Costa TS, Seffrin A, de Lira CAB, Vancini RL, Nikolaidis PT, Knechtle B, Rosemann T, Hill L, Andrade MS. Reduced level of physical activity during COVID-19 pandemic is associated with depression and anxiety levels: an internet-based survey. BMC Public Health 2021; 21: 613.
50) Silva LRB, Seguro CS, De Oliveira CGA, Santos POS, de Oliveira JCM, de Souza Filho LFM, de Paula Júnior CA, Gentil P, Rebelo ACS. Physical inactivity is associated with increased levels of anxiety, depression and stress in Brazilians during the COVID-19 pandemic: a cross-sectional study. Front Psychiatry 2020; 11: 565291.
51) Cheval B, Sivaramakrishnan H, Maltagliati S, Fessler L, Forestier C, Sarrazin P, Orsholits D, Chalabaev A, Sander D, Ntoumanis N, Boisgontier MP. Relationships between changes in self-reported physical activity, sedentary behaviour and health during the coronavirus (COVID-19) pandemic in France and Switzerland. J Sports Sci 2021; 39: 699-704.
52) Lavie CJ, Menezes AR, De Schutter A, Milani RV, Blumenthal JA. Impact of Cardiac Rehabilitation and Exercise Training on Psychological Risk Factors and Subsequent Prognosis in Patients With Cardiovascular Disease. Can J Cardiol 2016; 32: S365-S373.
53) Shahriarirad R, Erfani A, Ranjbar K, Bazrafshan A, Mirahmadizadeh A. The mental health impact of COVID-19 outbreak: a Nationwide Survey in Iran. Int J Ment Health Syst 2021; 15: 19.
54) Faulkner J, O'Brien WJ, McGrane B, Wadsworth D, Batten J, Askew CD, Badenhorst C, Byrd E, Coulter M, Draper N, Elliot C, Fryer S, Hamlin MJ, Jakeman J, Mackintosh KA, McNarry MA, Mitchelmore A, Murphy J, Ryan-Stewart H, Saynor Z, Schaumberg M, Stone K, Stoner L, Stuart B, Lambrick D. Physical activity, mental health and well-being of adults during initial COVID-19 containment strategies: A multi-country cross-sectional analysis. J Sci Med Sport 2021; 24: 320-326.
55) Diniz TA, Christofaro DG, Tebar WR, Cucato GG, Botero JP, Correia MA, Ritti-Dias RM, Lofrano-Prado MC, Prado WL. Reduction of Physical Activity Levels During the COVID-19 Pandemic Might Negatively Disturb Sleep Pattern. Front Psychol 2020; 11: 586157.
56) Torkian S, Akhlaghi E, Khosravi V, Etesami R, Ahmadi A. Depression Symptoms and Sleep Quality during COVID-19 Outbreak in Iran: A National Cross-Sectional Study. Iran J Psychiatry Behav Sci 2021; 15: e108500.
57) Zhai K, Gao X, Wang G. The role of sleep quality in the psychological well-being of final year UndergraduateStudents in China. Int J Environ Res Public Health 2018; 15: 2881.

58) Ramsawh HJ, Stein MB, Belik SL, Jacobi F, Sareen J. Relationship of anxiety disorders, sleep quality, and functional impairment in a community sample. J Psychiatr Res 2009; 43: 926-933.
59) Kline CE. The bidirectional relationship between exercise and sleep: implications for exercise adherence and sleep improvement. Am J Lifestyle Med 2014; 8: 375-379.
60) Harris MA. The relationship between physical inactivity and mental wellbeing: Findings from a gamification-based community-wide physical activity intervention. Health Psychol Open 2018; 5: 2055102917753853.
61) Dolezal BA, Neufeld EV, Boland DM, Martin JL, Cooper CB. Interrelationship between sleep and exercise: a systematic review. Adv Prev Med 2017; 2017: 1364387
62) Anderson EH, Shivakumar G. Effects of exercise and physical activity on anxiety. Front Psychiatry 2013; 4: 27.