

RESEARCH

Open Access



Physical activity behavior during Covid 19 pandemic among Iranian dwellers in Southern Iran based on planned behavior theory: a SEM analysis

Ali Khani Jeihooni^{1*}, Fatemeh Jafari², Ramin Shiraly³, Tayebeh Rakhshani¹, Abdolrahim Asadollahi⁴ and Hamed Karami²

Abstract

Background: The COVID-19 pandemic restrictions curtailed physical activity. The current study applied an integrated Theory of Planned Behavior to identify the determinants of physical activity behavior and the processes involved in the COVID-19 pandemic.

Methods: A cross-sectional study was conducted in Shiraz city, Southern Iran, among 2500 people who met the inclusion criteria were included in the study. Data were collected using the demographic information questions and questionnaire based on the Theory of Planned Behavior (TPB) constructs. The Questionnaire via WhatsApp, emails, and SMS was shared. Data analysis was performed using SPSS26 and Amos version 24. Mean and standard deviation was used to describe the data. Also, one-way ANOVA and structural equation analysis were used to analyze the data. The significance level in all the tests was considered to be 0.05.

Results: One thousand one hundred sixty-nine samples (46.8%) said they had been exercising less than 3 days a week, and 47.6% of them did not have any exercise or physical activities ($n = 1191$). The mean score of attitudes, SN, PBC, and intention were 9.38 ± 2.07 , 9.27 ± 2.03 , 9.32 ± 2.05 , and 12.29 ± 2.35 , respectively. The effect size values demonstrate the independent variables' high coefficient of influence on explaining the theoretical model. According to the results, the factors play an important role in samples' intention ($\eta^2 \geq 0.2$, $p \leq 0.05$). The effect size of intention on doing physical activities and exercise during the SARS-CoV-2 pandemic is Eta square = 0.777, which means the measure was high. The obtained model was good based on the main goodness of fit indices (Chi2 = 108.6, $df = 25$, $n = 2500$, Chi2/df = 4.344, RMSEA = 0.036, AGFI = 0.92, CFI = 0.95, GFI = 0.90, Fornell-Larcker criterion = 0.87, HTMT = 0.89).

Conclusion: The TPB provides a useful framework to explore psychosocial determinants of physical activity behavior during the pandemic and identify key strategies for program planning aimed at improving exercise among people who were already influenced by quarantine and lockdown restrictions.

Keywords: COVID-19, Physical activity, Structural equation modeling (SEM), Theory of planned behavior (TPB)

*Correspondence: Khani_1512@yahoo.com

¹ Nutrition Research Center, Department of Public Health, School of Health, Shiraz University of Medical Sciences, Shiraz P. Code:7153675541, Iran
Full list of author information is available at the end of the article

Background

At the end of 2019, a new coronavirus (now known as SARS-CoV-2) was discovered in Wuhan, China, and spread worldwide. On January 31, 2020, the World



Health Organization labeled the outbreak a worldwide public health emergency of international concern and declared it a global public health emergency [1]. Human-to-human virus transmission occurs through intimate contact with an infected individual and exposure to cough, sneeze, respiratory droplets, or airborne particles that can be inhaled through the nose or mouth [2]. Governments have progressively developed deterrent techniques, such as social separation and other societal restraints that may harm mental and physical health in response to the disease's epidemic and worldwide threat status [3]. In people at risk for cardiovascular disease, decreased physical activity levels during Covid 19 social isolation may rapidly lead to cardiovascular health issues and untimely death. Even brief inactivity (1 to 4 weeks) is associated with detrimental effects on cardiovascular structure and function and an elevated risk of cardiovascular disease [4]. Physical activity may have a significant role in the care of mild to moderate mental health illnesses, including depression and anxiety, and the symptoms of anxiety and panic disorder generally improve with regular exercise [5]. This topic specifies the function of models and theories of studying behavior in health education, given that human behavior is a reflection of various circumstances and health education is viewed as the focal point of health activities and programs [6]. The idea of planned behavior is one of the theories of behavior modification that can be used to predict and comprehend behavior to improve it [7]. The theory of planned behavior (TPB) has been extensively utilized to analyze and guide health-related activities, such as abstinence from alcohol/smoking and exercise and is impacted and predicted by views (favorable and unfavorable) [8]. This model has the ability to be used in studies related to screening for various diseases [9]. To date, no study has specifically used TPB in relation to Covid19 in Iran. According to this theory, the desire of individuals to engage in a particular activity is impacted by three primary factors: attitude, subjective norm, and perception of behavior control [10]. This idea proposes that a person's intention to engage in conduct is the closest key driver of behavior. The intention is a person's motive and desire to attempt to do a behavior [11]. Attitude is best defined as assessing a certain behavior and its perceived effects. Finally, perceived behavioral control (PBC) addresses control beliefs that include barriers and facilitators of behavior performance [12]. In conclusion, TPB demonstrates that intentions are the primary source of behavioral action, although intentions are afterwards recognized by emotional attitudes (anticipated pleasure) and instrumental attitudes (expected usefulness), subjective norm (perceived social pressure), and behavioral control. Excessive conduct is identified [13]. Physical activity, on

the other hand, has been demonstrated to be beneficial for mental health, but the significance of physical activity in relation to mental health during social distance owing to the epidemic of covid 19 in the Iranian community is not obvious at this time. Considering the type of study that evaluates the factors affecting the effectiveness of Covid-19 prevention measures during the epidemic in the Philippines [14] and suggests that it introduces the main idea of the TPB model to evaluate the effectiveness of COVID-19 measures in other countries. This structure with a larger sample size than the same study was selected and implemented for physical activity. As a result, the goal of this study was to explore the behavior of physical activity during the Covid 19 pandemic in Shiraz using the idea of planned behavior.

Methods

This is a cross-sectional study with a total research population of persons over 18 living in Shiraz city, Southern Iran. According to Chirico' study [15], the sample size is about 2500 Iranian citizens using convenience sampling approach. Information was submitted for sampling through social media platforms like as Instagram and Facebook, as well as through Shiraz University of Medical Sciences' official channels, and 2500 participants were considered in this study from June 2020 to September 2021. A social media platform i.e. WhatsApp was utilized to make the survey available for anyone to answer. Specifically, the survey was made available for anyone who has an account and is active on this social media. The online survey is fully anonymous and cannot be traced back to the respondents' identities, and their anonymity is guaranteed. Hiking routes and cycling tracks were created in collaboration with the municipality to encourage their cooperation. Individuals expressed their willingness to participate before answering the questions. A brief description of the study and its objective was also supplied. Participants were informed that the online survey is fully anonymous and cannot be tracked in terms of the respondents' identities, and their confidentiality is guaranteed.

Inclusion criteria: reading and writing literacy, possession of a cell phone, People over 18 (male and female), Shiraz residents. Fill out the informed consent form.

Criteria for exclusion: Reluctance to take part in the study.

Attitudes, subjective norms, PBC, and intention from the TPB were measured using measures utilized in previous studies [16].

The initial set of demographic information questions comprised age, gender, occupation, education, marital status, insurance coverage, recent travel, and outdoor living space measurements.

The second component included the Behavioral Regulation Questionnaire in Sport (BREQ-3) and the Autonomy Index Questionnaire (RAI), which yielded scores based on the questionnaire’s subscales. Positive scores suggest greater relative independence. Each item in the attitudes construct was preceded by “I believe conducting a physical exercise during this quarantine period is:” consisting of three items with responses supplied on 7-point semantic differential scales with the bipolar adjectives “wrong right,” “disadvantageous-advantageous,” and “useless-useful.”

Subjective Norms were determined by asking participants, for example, “would you prefer me to conduct physical exercise during this quarantine period?” Responses were provided on a 7-point Likert type scale (1 = “strongly disagree” and 7 = “strongly agree”). The item scores were combined into a single score, with higher values indicating greater normative societal pressure toward the activity.

PBC was assessed with three items (e.g., “I’m certain I can exercise during this quarantine period”) and responses on a 7-point Likert-type scale (e.g., 1 = “no control” and 7 = “strong control”). Item scores were combined into a single score, with higher values indicating better-perceived confidence in the behavior.

Finally, respondents were asked to express their intention on a 7-point Likert type scale (1 = “strongly disagree” and 7 = “strongly agree”) for four statements (e.g., “I expect to conduct physical exercise during this quarantine period”). Item scores were combined into a single score, with higher values indicating greater intent to engage in the behavior.

Cronbach’s alpha internal consistency approach was used to determine the reliability of the questions [15]. The final section consisted of seven-choice Likert-scale questions on the components of the theory of planned behavior, including three questions on attitudes, three on abstract, subjective norms, three on perceived behavioral control, and four on physical activity intention.

A total of 12 experts (outside the research team) were consulted for content validity in the areas of health education and health promotion (10 individuals) and infectious disease specialists (2 individuals).

Using structural equation modeling, relationships among the constructs were examined (SEM). Multivariate structural equation models (SEMs) combine different analytical methods (factor analysis and multiple regression analyses) to study and assess the relationships between latent and measured variables (measurement model) and between latent variables (structural model) while simultaneously accounting for measurement errors [17].

.Version 26 of SPSS and version 24 of Amos were used to undertake data analysis (IBM Co., Ann Arbore). The data were described by the mean and standard deviation. In addition, one-way ANOVA and structural equation analysis were applied to the data analysis. The level of significance for each test was deemed to be 0.05.

Results

Participant characteristics of the sample are presented in Table 1. Of the 2500 participants, 41.8 and 58.2% were male and female, respectively. The mean age of participants was 41.79 ± 15.21, 85.7% were married and 24% in other yards, 58.5% received less than 104 US\$ per month, and 1226 (49%) of participants had a high school diploma. (58.4%) of them lived in a house between 71 m² and 100

Table 1 Demographic characteristics of samples

Variables	Physical activity				p value
	Nothing	≤ 3 days	4–5 days	≤ 6 days	
Gender					
Male	513 (49.1%)	479 (45.9%)	29 (2.8%)	23 (2.2%)	0.474
Female	678 (46.6%)	690 (47.4%)	52 (3.6%)	36 (2.5%)	
Literacy					
Elementary	26 (44.8%)	29 (50%)	2 (3.4%)	1 (1.7%)	0.995
2nd School	372 (47.1%)	369 (46.8%)	27 (3.4%)	21 (2.7%)	
High School	594 (48.5%)	565 (46.1%)	40 (3.3%)	27 (2.2%)	
Graduated	199 (46.6%)	206 (48.2%)	12 (2.8%)	10 (2.3%)	
Occupation					
Employee	194 (43.1%)	231 (51.3%)	16 (3.6%)	9 (2%)	0.526
worker	97 (48%)	93 (46%)	10 (5%)	2 (1%)	
free	370 (48.9%)	341 (45.1%)	26 (3.4%)	19 (2.5%)	
Housewife	297 (47.7%)	293 (47%)	17 (2.7%)	16 (2.6%)	
other	233 (49.7%)	211 (45%)	12 (2.6%)	13 (2.8%)	
Marital Status					
Non-married	197 (45.5%)	212 (49%)	10 (2.3%)	14 (3.2%)	0.247
Married	994 (48.1%)	957 (46.3%)	71 (3.4%)	45 (2.2%)	
Income (per month)					
≤ 104 US\$	500 (48.2%)	483 (46.5%)	29 (2.8%)	26 (2.5%)	0.712
≥ 105 US\$	691 (47.3%)	686 (46.9%)	52 (3.6%)	33 (2.3%)	
Area of the Home (m²)					
≤ 70	411 (50.3%)	354 (43.3%)	27 (3.3%)	25 (3.1%)	0.286
71–100	421 (45.6%)	460 (49.8%)	27 (2.9%)	16 (1.7%)	
≤ 101	359 (47.4%)	354 (46.7%)	27 (3.6%)	18 (2.4%)	
Availability of Outdoors					
Balcony	159 (50.5%)	143 (45.4%)	8 (2.5%)	5 (1.6%)	0.004
Terrace	839 (47%)	843 (47.2%)	68 (3.8%)	35 (2%)	
Garden	137 (48.1%)	128 (44.9%)	4 (1.4%)	16 (5.6%)	
Nothing	43 (45.3%)	50 (52.6%)	0 (0%)	2 (2.1%)	

m².* The next question was the availability of outdoors such as balcony, terrace, backyard, and garden at home. About 71.4% of samples said their house has a terrace and use it (n = 1785). A question was about the time of physical activity during the coronavirus pandemic, and 1169 samples (46.8%) said they had been exercising less than 3 days a week, and 47.6% did not exercise or do physical activities (n = 1191). The mean score of attitude, SN, PBC, and intention were 9.38 ± 2.07, 9.27 ± 2.03, 9.32 ± 2.05, and 12.29 ± 2.35, respectively. According to Table 1, there is no relationship between demographic variables and physical activity, except for the outdoor access variable.

Table 2 Fixed Effect ANOVA Results for TPB Constructs

Fixed Factors	df	F	Effect Size ^a	Partial η ² 90% CI [LL,UL]	Sig.
1. Intention					
Attitude	2488	9.551	.241	[.184, .351]	.000*
SN	2490	5.607	.220	[.137, .281]	.000*
PBC	2490	5.127	.218	[.134, .288]	.000*
2. Physical Activity					
Intention	2487	721.39	.777	[.654, .891]	.000**

^a Using Eta square (η²), * p < .05, ** p < .01

According to Table 2, the fixed effect ANOVA results were obtained for TPB constructs. The effect size values demonstrate the independent variables' high coefficient of influence on explaining the theoretical model.

According to the results, the factors play an important role in samples' intention (η² ≥ 0.2, p ≤ 0.05). The effect size of intention on doing physical activities and exercise during the SARS-CoV-2 pandemic is Eta square = 0.777, and it means the measure was high (See Fig. 1, Spearman's rho coefficient = .84, p < .01) The three constructs of the theoretical model and demographic variables were entered into the model using the SEM. Out of 3 extraction models, according to Table 3 and Fig. 2, the following model with the highest fit index was obtained.

According to the Fig. 2, the obtained model was good based on the main goodness of fit indices (Chi2 = 108.6, df = 25, n = 2500, Chi2/df = 4.344, RMSEA = 0.036, AGFI = 0.92, CFI = 0.95, GFI = 0.90).

Discriminant validity is referring to being different between constructs from one another empirically. It can be evaluated by using cross-loading of indicator i.e. the Fornell-Larcker criterion and Heterotrait-monotrait (HTMT) ratio of correlation and the values were 0.87 and 0.89 respectively. Also, the composite reliability (CR) index i.e. maximum shared squared variance (MSV) was calculated and it was a good reliability for all factors (all above 0.78).

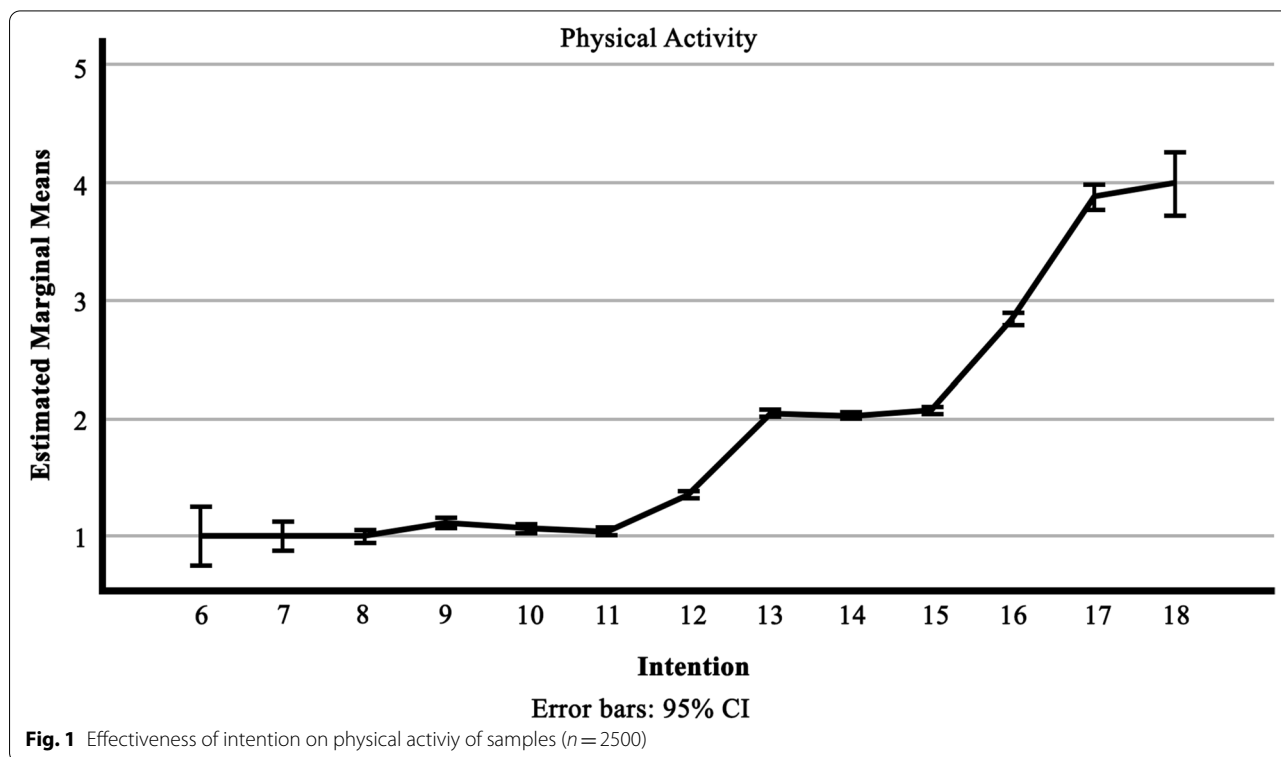


Fig. 1 Effectiveness of intention on physical activity of samples (n = 2500)

Table 3 Result of three construct of theoretical model along with demographic variables by SEM

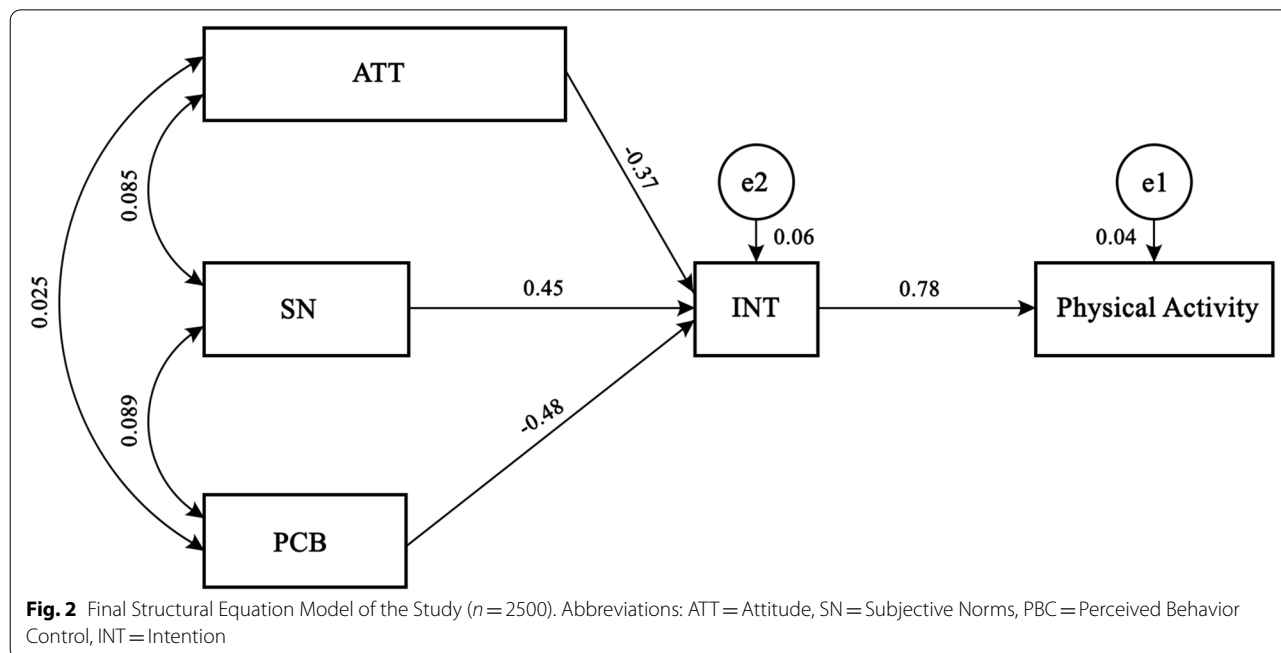
Examined Paths	Mean	SD	Standardized Path Coefficients
ATT	9.38	3.07	
ATT → INT			-0.37
SN	9.27	2.03	
SN → INT			0.45
PBC	9.32	2.05	
PBC → INT			-0.48
INT	12.29	2.35	
INT → Phy.Act.			0.78
Phy.Act. ^{a-b}			
Level 1	1191 (47.6)		
Level 2	1169 (46.8)		-
Level 3	140 (5.6)		
Model Fit	Chi2 = 108.6, df = 25, n = 2500, Chi2/df = 4.344, RMSEA = 0.036, AGFI = 0.92, CFI = 0.95, GFI = 0.90, MSV ≥ 0.78, Fornell-Larcker criterion = 0.87, HTMT = 0.89.		

Note: ATT Attitude, SN Subjective norms, PBC Perceived behavioral control, and INT = intention

* $p \leq 0.05$

^a Level 1 = No physical activity, level 2 = Less than 3 days per week, and level 3 = More than 4 days per week

^b Frequencies (%)



Furr (2011) indicated that the fit indices should have standardized loadings of 0.80 and more [18]. The model also has good fit indices (see Fig. 2).

Discussion

The current study sought to examine the relations between social-cognitive variables and PA behavior

during the COVID-19 pandemic, using SEM to test a two-component model of the TPB for PA in a sample of Iranian adults. As expected, the TPB constructs were significantly correlated to engaging in physical activity during the pandemic. This finding suggests that TPB applies to PA behaviors in the pandemic situation. Participants with higher intentions were more likely to report higher physical activity levels. There were significant model pathways to the intention from ATT, SN, and PBC. However, the PBC seems to have the strongest indirect effect on PA levels. These findings align with previously published TBP studies of PA behavior during the pandemic [19, 20]. In another study that aimed to examine the factors affecting the perceived effectiveness of prevention using TPB theory, they concluded that according to PBC, people with sufficient knowledge stay at home more and follow the implementation of quarantine in the community [14]. A meta-analysis by McEachan et al. demonstrated that, regardless of the kind of health behavior, ATT and PBC are the strongest variables associated with behavioral intention [21]. Also, Lau et al. stated that factors derived from TPB are significantly associated with behavioral intention [22]. In a similar study by Prasetyo et al. it was indicated that intention to follow was significantly affected by PBC, SN, and ATT [14]. Moreover, based on the results of this study, direct effects showed that the perception of COVID-19 did not have a significant direct effect on attitude, but its indirect effect was significant, and our findings support that PBC and ATT have a more powerful influence on physical activity engagement in the pandemic time than SN.

Based on our results, approximately half (48%) of Iranian adults reported no physical activity or exercise during the pandemic, and just over 5% of participants reported exercising more than 3 times a week. World Health Organization (WHO) recommends that people aged 18 to 64 engage in at least 150 minutes of moderate PA per week [23]. Pre-pandemic data suggest that most adults do not follow recommended guidelines. For example, the Center for Disease Control (CDC) estimates that more than 60% of U.S. adults did not engage in the recommended amount of PA before the pandemic, and almost 25% of people were not active at all [24]. COVID-19 pandemic has negatively affected all PA levels among adult population [25]. Our findings raise serious concerns about the negative effects of the pandemic on PA behaviors of Iranian adults as it demonstrated that more than 90% of Iranian adults do not meet the recommended guideline. This issue suggests a large-scale behavioral change.

Overall, our findings provide better insight into understanding theory-grounded psychosocial variables associated with physical activity behavior during the pandemic

situation. Across all the TPB constructs, the most notable themes that emerged included PBC and SN. Therefore, pandemic response policies should address these issues, which may be pivotal for program planning.

There are some limitations to this study that should be noted. This was a cross-sectional survey by which changes in the theoretical mediators and PA behavior over time can not be evaluated as this evaluation needs a longitudinal study design. Online data collection restricts the generalizability of the results, as sampling bias is unavoidable in web-based surveys. Anxiety about COVID-19 has been suggested as a significant factor that regulates physical activity intention and participation during the pandemic [21]; however, the current study did not assess this variable among the studied population.

Conclusion

In conclusion, the TPB provides a useful framework to explore psychosocial determinants of physical activity behavior during the pandemic and identify key strategies for program planning aimed at improving exercise among people who were already influenced by quarantine and lockdown restrictions.

Abbreviations

ATT: Attitude; SN: Subjective Norms; PBC: Perceived Behavior Control; INT: Intention; SEM: Structural Equation Model; PA: Physical Activity; TPB: Theory of Planned Behavior.

Acknowledgements

Our warm thanks go to the Research and Technology Dept. of Shiraz University of Medical Sciences, as well as Shiraz dwellers for their participation in the study.

Authors' contributions

AKHJ, FJ, RS, TR, AA and HK assisted in conceptualization and design of the study, oversaw data collection, conducted data analysis and drafted the manuscript. AKHJ and AA has analyzed the data and extracted the SEM models. AKHJ, FJ, RS and HK assisted in study conceptualization and reviewed the manuscript. All authors read and approved the final manuscript.

Funding

None.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate

The ethics committee approved this study protocol of Shiraz University of Medical Sciences (IR.SUMS.SCHEANUT.REC.1400.001). Informed consent for participation in the study was obtained from all participants. The ethics committee approved the procedure for verbal consent since the study is observational and respected the code of ethics stated in Helsinki's declarations.

Consent for publication

None.

Competing interests

The authors declare that they have no competing interests.

Author details

¹Nutrition Research Center, Department of Public Health, School of Health, Shiraz University of Medical Sciences, Shiraz P. Code:7153675541, Iran. ²Student Research Committee, Shiraz University of Medical Sciences, Shiraz, Iran. ³Department of Community Medicine, School of Medicine, Health Behavior Science Research Center, Shiraz University of Medical Sciences, Shiraz, Iran. ⁴Department of Health Promotion, School of Health, Shiraz University of Medical Sciences, Shiraz, Iran.

Received: 24 April 2022 Accepted: 13 July 2022

Published online: 22 July 2022

References

- Bulut C, Kato Y. Epidemiology of COVID-19. *Turkish J Med Sci*. 2020;50(SI-1):563–70.
- Shereen MA, Khan S, Kazmi A, Bashir N, Siddique R. COVID-19 infection: emergence, transmission, and characteristics of human coronaviruses. *J Adv Res*. 2020;24:91–8.
- Wunsch K, Kienberger K, Niessner C. Changes in physical activity patterns due to the Covid-19 pandemic: a systematic review and Meta-analysis. *Int J Environ Res Public Health*. 2022;19(4):2250.
- Peçanha T, Goessler KF, Roschel H, Gualano B. Social isolation during the COVID-19 pandemic can increase physical inactivity and the global burden of cardiovascular disease. *Am J Physiol Heart Circ Physiol*. 2020;318(6):H1441–h6.
- Paluska SA, Schwenk TL. Physical activity and mental health: current concepts. *Sports Med*. 2000;29(3):167–80.
- Barati M, Allahverdipour H, Moeini B, Farhadi NA, Mahjub H, Jalilian F. Assertiveness skills training efficiency on college students'persuasive subjective norms against substance abuse. 2011.
- Aghamolaei T, Farshidi H, Safari-Moradabadi A, Dadipoor S. Effect of interventions based on the theory of planned behavior on promoting physical activity: a systematic review. *J Prev Med*. 2016;3(4):1–5.
- Sur MH, Jung J, Shapiro DR. Theory of planned behavior to promote physical activity of adults with physical disabilities: Meta-analytic structural equation modeling. *Disabil Health J*. 2022;15(1):101199.
- Booth AR, Norman P, Harris PR, Goyder E. Using the theory of planned behaviour and self-identity to explain chlamydia testing intentions in young people living in deprived areas. *Br J Health Psychol*. 2014;19(1):101–12.
- Gaston A, Cramp A. Exercise during pregnancy: a review of patterns and determinants. *J Sci Med Sport*. 2011;14(4):299–305.
- Shirvani ZG, Ghofranipour F, Gharakhanlou R, Kazemnejad A. Determinants of physical activity based on the theory of planned behavior in Iranian military Staff's wives: a path analysis. *Global J Health Sci*. 2015;7(3):230.
- Stehr P, Rossmann C, Kremer T, Geppert J. Determinants of physical activity in older adults: integrating self-concordance into the theory of planned behavior. *Int J Environ Res Public Health*. 2021;18(11):5759.
- Rhodes RE, Beauchamp MR, Quinlan A, Symons Downs D, Warburton DER, Blanchard CM. Predicting the physical activity of new parents who participated in a physical activity intervention. *Soc Sci Med*. 2021;284:114221.
- Prasetyo YT, Castillo AM, Salonga LJ, Sia JA, Seneta JA. Factors affecting perceived effectiveness of COVID-19 prevention measures among Filipinos during enhanced community quarantine in Luzon, Philippines: integrating protection motivation theory and extended theory of planned behavior. *Int J Infect Dis*. 2020;99:312–23.
- Chirico A, Lucidi F, Galli F, Giancamilli F, Vitale J, Borghi S, et al. COVID-19 outbreak and physical activity in the Italian population: a cross-sectional analysis of the underlying psychosocial mechanisms. *Front Psychol*. 2020;11:2100.
- Galli F, Chirico A, Mallia L, Girelli L, De Laurentis M, Lucidi F, et al. Active lifestyles in older adults: an integrated predictive model of physical activity and exercise. *Oncotarget*. 2018;9(39):25402.
- Gana K, Broc G. Structural equation modeling with lavaan: London, Wiley; 2019.
- Furr M. Scale construction and psychometrics for social and personality psychology: London, SAGE publications ltd; 2011.
- Cheng X, Chen W. Understanding Residents' Physical Activity Intention and Behavior Amid COVID-19 Pandemic. *Front Psychol*. 2022;13:760702.
- Jang D, Kim I, Kwon S. Motivation and intention toward physical activity during the COVID-19 pandemic: perspectives from integrated model of self-determination and planned behavior theories. *Front Psychol*. 2021;12:714865.
- Galli F, Giancamilli F, Palombi T, Vitale JA, Borghi S, De Maria A, et al. Anxiety, motives, and intention for physical activity during the Italian COVID-19 lockdown: an observational longitudinal study. *Int J Environ Res Public Health*. 2022;19(8):4689.
- Lau JT, Yeung NC, Choi K, Cheng MY, Tsui H, Griffiths S. Factors in association with acceptability of A/H1N1 vaccination during the influenza A/ H1N1 pandemic phase in the Hong Kong general population. *Vaccine*. 2010;28(29):4632–7 Ammar A, Brach M, Trabelsi K, Chtourou H, Boukhris O, Masmoudi L et al. Effects of COVID-19 Home Confinement on Eating Behaviour and Physical Activity: Results of the ECLB-COVID19 International Online Survey. *Nutrients*. 2020 May 28;12(6):1583. doi: 10.3390/nu12061583. PMID: 32481594; PMCID: PMC7352706.
- World Health Organization. Global action plan on physical activity 2018–2030: more active people for a healthier world.available at 2022/4/19.
- Centers for Disease Control and Prevention (CDC). Adults/ Surgeon General Report/ CDC. <https://www.cdc.gov/nccdphp/sgr/adults.htm>.
- Papaspanos N. Effects of COVID-19 home confinement on eating behaviour and physical activity: results of the ECLB-COVID19 international online survey. *Kompass Nutr Diet*. 2021;1(1):19–21.

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Ready to submit your research? Choose BMC and benefit from:

- fast, convenient online submission
- thorough peer review by experienced researchers in your field
- rapid publication on acceptance
- support for research data, including large and complex data types
- gold Open Access which fosters wider collaboration and increased citations
- maximum visibility for your research: over 100M website views per year

At BMC, research is always in progress.

Learn more biomedcentral.com/submissions

