

# Times in Physical Activity and Sedentary Behavior Associated with Awareness and Knowledge of the 2008 Physical Activity Guidelines for Americans

Heontae Kim, PhD

Harold W. Kohl III, PhD

Ho Han, PhD

**Objective:** In this study, we examined the associations between awareness and knowledge of the *2008 Physical Activity Guidelines for Americans* and device-based measures of physical activity (PA). **Methods:** Overall, 222 college students participated in the current study. Based on their awareness and knowledge of the *2008 Guidelines*, the participants were categorized into 3 groups: don't know, awareness only, and knowledge. We used 2 questions for identifying awareness and knowledge of government PA guidelines. Accelerometers were employed to evaluate times spent in moderate-to-vigorous intensity physical activity (MVPA). Comparison among the 3 groups was conducted for total time spent in MVPA using one-way Welch ANOVA. **Results:** There was a statistically significant difference in the average time of MVPA by the knowledge of the *2008 Guidelines* ( $p = .035$ ). The knowledge group had a greater average time of MVPA compared to the other 2 groups; we found no statistically significant difference in MVPA between the awareness only and don't know groups. **Conclusion:** Knowledge of the *2008 Guidelines* was positively associated with PA levels among college students. More effective dissemination of PA guidelines would appear to be warranted in promoting PA.

**Key words:** exercise; sitting time; sedentariness; health promotion; college students; college health

*Health Behav Policy Rev.*™ 2020;7(1):19-26

DOI: <https://doi.org/10.14485/HBPR.7.1.3>

Physical activity (PA) is one of the factors influencing health in modern society with increased evidence of beneficial associations with various health outcomes. More specifically, regular PA reduces the risk of hypertension, type 2 diabetes, obesity, and breast and colon cancers.<sup>1-4</sup> In addition to such disease preventive benefits of PA, a governmental scientific report demonstrates a variety of other benefits of PA including improving physical function (eg, reducing risk of falls and fall-related injuries), quality of sleep (eg, increasing the tie in deep sleep), and quality of life (improving

mental or emotional health).<sup>5</sup>

As the demand for PA promotion increased, in 1996, the US Department of Health and Human Services (USDHHS) issued the Surgeon General's Report, particularly focusing on the relationship between PA and health. The report included a public health recommendation: "Every US adult should accumulate 30 minutes or more of moderate-to-vigorous intensity physical activity (MVPA) on most, preferably all, days of the week."<sup>6</sup> In 2008, the *2008 Physical Activity Guidelines for Americans* was published as a result of continuous efforts to pro-

*Heontae Kim, Post-doctoral Research Associate, School of Applied Sciences, The University of Mississippi, University, MS. Harold W. Kohl III, Professor, Division of Epidemiology, Human Genetics and Environmental Sciences, School of Public Health Austin Regional Campus, University of Texas Health Science Center at Houston, Austin, TX. Ho Han, Assistant Professor, School of Community Health Sciences, Counseling and Counseling Psychology, Oklahoma State University, Stillwater, OK.  
Correspondence Dr Han; [hohan@okstate.edu](mailto:hohan@okstate.edu)*

vide better PA guidelines for different age groups.<sup>7</sup> In the updated *2008 Guidelines* recommended for adults to engage in at least 150 minutes of moderate-intensity or 75 minutes of vigorous-intensity aerobic PA each week, or a corresponding combination thereof in bouts of 10 minutes (ie, preferable, spread throughout the week). More recently, the second edition of *Physical Activity Guidelines for Americans* was released in 2018.<sup>5</sup> The second edition provides new aspects of PA including further benefits of PA in additional body sites and disease conditions for different ages and populations. In addition, the 10-minute requirement for achieving optimal health benefit was eliminated in this latest version.

Some estimates show that many adults do not engage in a sufficient amount of PA as specified in the *2008 Guidelines*. Overall, 36.6% of Americans were inactive, and only 43.5% met the minimum recommend amount of aerobic PA.<sup>8</sup> Owing to the challenges of self-report of PA behaviors, Tucker et al<sup>9</sup> reported that only 8.2% of American met the *2008 Guidelines* when PA was measured by accelerometers.

College students are in a period of developing their self-management skills influencing long-term health behaviors that affect them for the rest of their lives.<sup>10</sup> However, insufficient PA participation in this population has been reported consistently by various studies.<sup>9</sup> The 2017 American College Health Association health assessment indicated that 47.4% of college students met the currently recommended PA guidelines.<sup>11</sup>

Some research has reported the prevalence of awareness and knowledge of the *2008 Guidelines*.<sup>12,13</sup> According to Kay et al,<sup>12</sup> 36.1% of nationally representative sample reported that they have been seen, heard, or read anything about the *2008 Guidelines* in the past years. However, the percent of adults that knew the minimum amount of PA the *2008 Guidelines* recommended for adult to overall health benefit was only 0.56%.<sup>12</sup> Researchers contend that the first step in initiating behavior change is to be made aware and knowledgeable of the action.<sup>14,15</sup> However, there is still a lack of information available on the PA levels associated with awareness and knowledge of the *2008 Guidelines*. Thus, in this study, we determined the associations between awareness and knowledge of the *2008 Guidelines* for Americans and device-based measures of PA.

## METHODS

### Participants and Protocol

A total of 222 college students (115 men and 107 women) aged 18 to 24 years, who were healthy and had no issues with normal daily ambulation, participated in the current study. The participants represented a wide range of academic disciplines on campus (eg, economics, sociology, biology), and the participation was both voluntary and anonymous. All participants provided written informed consent prior to participation.

After informed consent, the participants received a triaxial accelerometer (ActiGraph GT3X+, Pensacola, FL) with both verbal and written instructions including a link to an instructional YouTube video. Participants were instructed to wear the activity monitor on their right hip, in line with the mid-axillary line, for 7 consecutive days, during all waking hours of the day and to remove for extended contact with water (eg, swimming and taking shower). After the completion of 7-day data collection, participants returned the devices and completed a package of questionnaires including questions about demographic information and awareness/knowledge of the *2008 Guidelines*.

### Measures

To facilitate comparisons with other studies and population groups,<sup>12,13</sup> we used identical questions for identifying awareness and knowledge of the PA guidelines.

**Awareness.** Participants were asked: “Have you seen, heard, or read anything about government physical activity guidelines in the past years?” and answered *yes*, *no*, or *not sure*. If they answered *yes*, they were considered as being aware of the PA guidelines.

**Knowledge.** It was asked: “What is the minimum amount of physical activity the government recommends for adult to overall health benefit? (eg, duration, frequency, and/or intensity)”. Those who answered either 150 minutes a week of moderate-intensity aerobic PA or an equivalent combination of PA intensity and/or time (eg, 30 minutes a day in 5 or more days a week, 75 minutes a week of vigorous-intensity aerobic PA, or an equivalent combination of moderate- and vigorous-intensity aerobic activity) were considered as having knowl-

**Table 1**  
**Demographic Characteristics by Awareness and Knowledge Levels**

Variables	Total (N = 222)	Don't know (N = 167)	Awareness only (N = 34)	Knowledge (N = 21)
	N or mean	% or mean	% or mean	% or mean
<b>Age (years)</b>	20.4 ± 1.8	20.4 ± 1.8	19.9 ± 0.9	21.0 ± 2.6
<b>Sex</b>				
Male	115	73.8	15.0	11.2
Female	107	76.5	15.7	7.8
<b>College Year</b>				
1	10	90.0	10.0	0
2	81	76.5	13.6	9.9
3	68	67.7	25.0	7.3
4	63	79.4	7.9	12.7
<b>Race</b>				
White	81	64.2	19.8	16
Black	23	78.3	21.7	0
Hispanic	63	76.2	15.9	7.9
Asian	55	89.1	5.5	5.4
<b>BMI</b>				
Normal	155	77.3	14.3	8.4
Overweight	58	72.4	17.2	10.4
Obese	9	60.0	20.0	20

Note.

BMI = body mass index

edge of the *2008 Guidelines*. This question was modified from multiple choices (eg, 6 options) to short answer to prevent randomly selected answers.

**Device-based measures of PA and sedentary time.** Times spent in MVPA and sedentary behaviors were measured objectively using the ActiGraph GT3X+ accelerometer (Pensacola, FL). A one-second epoch length was used for data collection. Wear time validation was conducted using the cut-point requiring a minimum of 10 hours of wear time for at least 4 of 7 days.<sup>16</sup> Freedson cut-points were used to estimate times spent in sedentary behaviors (<100 counts per minute), moderate- (1952-5724 counts per minute), and vigorous- (≥5725 counts per minute) intensity PA.<sup>17</sup> A bouted-MVPA was calculated using the definition of a minimum of 10 consecutive minutes above the moderate-intensity

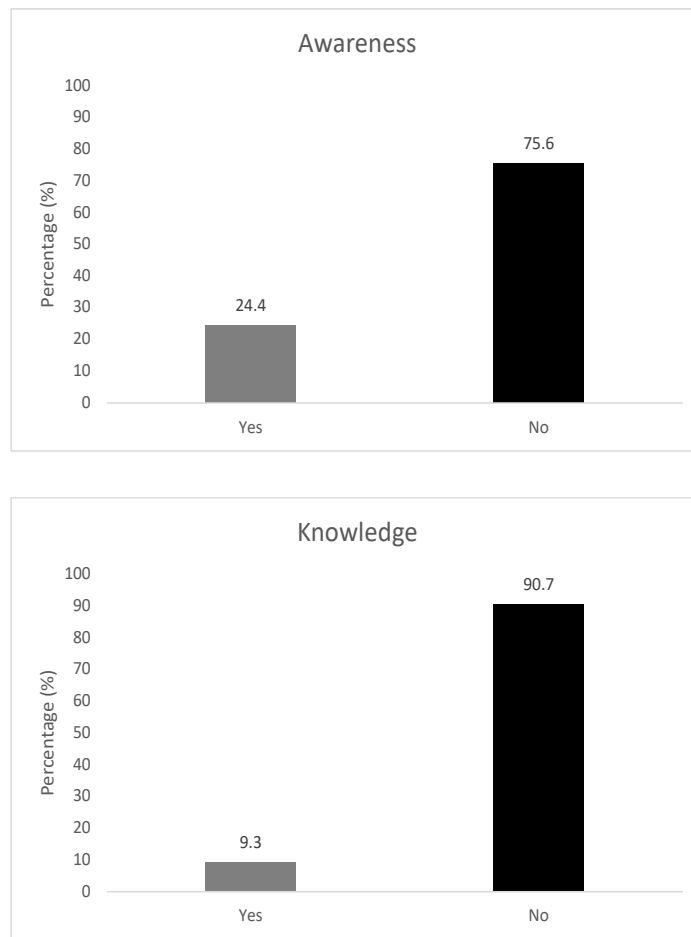
threshold (≥1952 counts per minute) with allowance of 2 minutes below the threshold.<sup>12</sup> In addition, the amount of time accumulated below 100 counts per minute during a period of wearing time was considered as total sedentary time.<sup>18</sup>

### Data Analysis

All data management and analyses were conducted using SPSS version 23 (IBM Corp, Armonk, NY). Descriptive statistics were expressed as frequency, percentage and means ± standard deviations to summarize characteristics about participants and the dependent variables.

For comparing MVPA and sedentary behavior (SB) time associated with awareness and knowledge of the *2008 Guidelines*, participants were cat-

**Figure 1**  
**Awareness and Knowledge of Physical Activity Guidelines**



egorized into 3 groups as follows:

- *Don't know.* Participants in this group have never seen, heard, or read anything about the *2008 Guidelines* in the past years at all.
- *Awareness only.* Participants in this group have seen, heard, or read anything about the *2008 Guidelines* in the past years, but they don't know or know incorrectly the recommendation of 150 minutes/week of MVPA.
- *Knowledge.* Participants in this group know correctly the recommendation of 150 minutes/week of MVPA.

Differences of MVPA and SB time between all demographic variables were examined by one-way Welch analysis of variance (ANOVA). Also, com-

parison among the 3 groups was conducted for total time spent in MVPA time using one-way Welch ANOVA. The effects of group (don't know, awareness only, knowledge) was tested. Statistical significance was set at .05.

## RESULTS

Detailed participant characteristics are presented in Table 1. The average age was  $20.4 \pm 1.8$  years. Although not shown in Table 1, as additional information, 43.0% of our participants met or exceeded the *2008 Guidelines* of 150 minutes/week of MVPA. Study participants spent, on average,  $22.9 \pm 14.5$  and  $493.0 \pm 149.2$  minutes per day engaged in MVPA and SB, respectively. Also, MVPA and SB were not systematically associated with any

**Table 2**  
**Descriptive Statistics for MVPA and SB by Levels of Awareness and Knowledge**

Group	N	Mean (SD)	F	p
<b>MVPA (minutes/day)</b>				
Don't know	167	22.6 (14.2)	3.6	.035
Awareness only	34	19.3 (12.8)		
Knowledge	21	31.1 (17.3)		
<b>SB (minutes/day)</b>				
Don't know	167	495.2 (152.2)	0.2	.798
Awareness only	34	492.7 (155.9)		
Knowledge	21	476.3 (115.4)		

**Note.**

**MVPA = moderate-to-vigorous physical activity; SB = sedentary behavior**

demographic variables (eg, sex, college year, race, BMI levels;  $p > .05$ ).

We estimated a prevalence of 24.4% of college students had seen, read, or heard of government guidelines. Also, 9.3% of college student were knowledgeable about the *2008 Guidelines* (Figure 1).

The one-way Welch ANOVA was used to examine whether average time of MVPA and SB are different by awareness and knowledge of the *2008 Guidelines*. Alpha level was set at .05. The result indicated that there was a significant difference in the average time of MVPA by the knowledge of the *2008 Guidelines* ( $p = .035$ ; Table 2).

The *post hoc* test using Tukey's HSD was used to conduct pairwise comparison. The *post hoc* test indicated that the knowledge group has a greatest average of MVPA than awareness only and don't know groups. However, there is no significant difference in MVPA between the awareness only and don't know group. Table 3 shows the Tukey's HSD comparison. Additionally, for SB, the result indicated that there is no significant difference in the average of SB by awareness and knowledge levels ( $p = .798$ ).

## DISCUSSION

The purpose of this study were to estimate the prevalence of awareness and knowledge of the *2008 Physical Activity Guidelines for Americans* and to determine the associated PA and sedentary be-

havior in college students. The current results indicate that 24.4% of college students reported being aware of the *2008 Guidelines*. Furthermore, only 9.3% of the participants correctly identified the currently recommended moderate- to vigorous-intensity PA guidelines (eg, 150 minutes/week). Also, college students who were knowledgeable of the *2008 Guidelines* had a greater average time of MVPA than those who were either aware or unaware of the *2008 Guidelines*.

Kay et al<sup>12</sup> reported that only 36.1% and 0.56% of nationally representative sample were aware and knowledgeable of the *2008 Guidelines*, respectively, at the time of the data collection (ie, less than a year from the release). When compared with these results, despite the passage of time, the consistent results were found in the current study among college students, and the prevalence of awareness and knowledge of the *2008 Guidelines* still remained low in the population. According to Kay et al,<sup>12</sup> concentrated media efforts that occurred for only 3 months after the release of the *2008 Guidelines* may be attributable to the low level of awareness and knowledge level of the *2008 Guidelines*. Additionally, population-level PA promotion to improve the health has only had a perceptible infrastructure since 2000 and is one step behind compared to other important public health issues such as tobacco and alcohol control and diet.<sup>19</sup> This suggests the needs of concerted long-term approaches to increase knowledge of, and compliance

**Table 3**  
**Tukey HSD Comparison for MVPA by Levels of Awareness and Knowledge**

(I) Group	(J) Group	Mean Diff. (I-J)	Std. Error	95% CI	
				Lower	Upper
Knowledge	Don't know	8.5*	3.3	0.7	16.3
Knowledge	Awareness only	11.8*	4.0	2.5	21.2
Awareness only	Don't know	-3.3	2.7	-9.7	3.0

\* p < .05

**Note.**

MVPA = moderate-to-vigorous physical activity; Diff = differences, CI = confidence interval

with the current PA guidelines.

The importance of knowledge of PA guidelines was demonstrated in this study. According to the current study, when college students were knowledgeable of the currently recommended PA guidelines, they had a significantly higher level of MVPA compared to those who were aware only or unaware at all of the guidelines. Similar findings appear in recent studies focusing on other behaviors besides PA. Previous work demonstrated that increased knowledge of *Dietary Guidelines for Americans 2005* positively related to more healthful dietary choices and eating patterns among college students.<sup>20</sup> Additionally, people showed a tendency to consume the amount of daily recommendation for fruits and vegetables if they were knowledgeable of the fruit and vegetable recommendation.<sup>21</sup> According to some health behavior theories such as Precaution Adoption Process Model and Protection Motivation Theory, individuals must be aware their desired actions to be able to initiate a positive change.<sup>22-24</sup> This research and set of theories emphasize the importance of knowledge, which aligns with our findings.

In 2018, the USDHHS released the second edition of *Physical Activity Guidelines for Americans*.<sup>5</sup> The report includes the scientific evidence on PA and health, and modified PA guidelines. Successful promotion of the second edition can be enhanced from clear and repeatable messages about the target population. With the recent rapid increase in the generation of social media and development of mo-

bile devices, people have been able to obtain large quantities of information. In this environment, public relations about the new guidelines must be disseminated in an organized way, with repetition and frequency, targeting to several areas of society such as in healthcare, school, worksites, and communities. The success of the US Centers for Disease Control and Prevention's VERB Campaign<sup>25</sup> and National Cholesterol Education Program<sup>26</sup> can be good models for a PA campaign to inform and disseminate updated PA guidelines.

In addition to the major findings, our study revealed a lack of association between knowledge of the recommended PA guidelines and sedentary behavior (ie, sitting time) supporting the independence of sedentary behavior from moderate- to vigorous-intensity PA.<sup>27,28</sup> This fact implies that sedentary behavior is another class of behaviors that is not displacing MVPA. As sedentary behavior can result in various adverse health outcomes,<sup>29</sup> further actions including public health initiatives, policy and environmental changes and governmental guidelines for sedentary behavior may be required.

**Limitations and Strengths**

This study has several limitations that must be acknowledged. First, our participants represented a convenience sample of college students, thereby making it difficult for our finding to be generalized to other college populations or other adults. However, our results in relation to the prevalence of awareness and knowledge of the *2008 Guidelines*

and the proportion of college students meeting the currently recommended PA levels are consistent with previous studies such as those by Kay et al<sup>12</sup> and 2017 ACHA health assessment report,<sup>7</sup> suggesting the findings from our study are acceptable. In addition, our study dealt with one component of the *2008 Guidelines* (ie, the MVPA component) although the *2008 Guidelines* include other recommendations such as muscle-strengthening activities. Lastly, we used Freedson cut-points<sup>17</sup> to estimate times spent in PA, but there is still a lot of variability in the thresholds used. Therefore, these thresholds may affect our results.

However, this study has several strengths. Our study is the first to report examining device-based measures of PA associated with awareness and knowledge of the *2008 Guidelines* among college students. Our findings can help guide strategies or interventions to promote PA. Also, PA was measured objectively by accelerometers, and resulted in providing more objective evidence to show the relationship between PA time and awareness and knowledge of the *2008 Guidelines*.

## IMPLICATIONS FOR HEALTH BEHAVIOR OR POLICY

Our results reveal an association between the amount of PA and knowledge of the *2008 Physical Activity Guidelines for Americans*. Our findings can help health researchers, practitioners, and policymakers improve their intervention program and health policy, which can be applied in schools, healthcare facilities, and communities.

Improvement to health, fitness, and quality of life through increasing daily PA is one of the priority objectives of *Healthy People 2020* and identified health topic in the World Health Organization. Nevertheless, greater than half of US college students do not engage in a sufficient amount of PA as specified in the *2008 Guidelines*.<sup>30</sup> To our knowledge, however, there is still a lack of information available concerning the relationship between PA level and knowledge of PA guidelines. Our findings indicated that knowledge of the PA guidelines was positively associated with PA levels among college students. PA promotion using the PA guidelines is warranted for college students. Lastly, our results support a need for successful dissemination of the PA guidelines. With the release of the second edi-

tion of the *Physical Activity Guidelines for Americans*, effective means for promoting the contents of this edition are required.

## Human Subjects Approval Statement

This study was approved by the University of Texas at Austin Institutional Review Board. Informed consent was obtained from all participants included in the study.

## Conflict of Interest Disclosure Statement

The authors have no conflict of interest to declare.

## References

1. White DK, Gabriel KP, Kim Y, et al. Do short spurts of physical activity benefit cardiovascular health? The CARDIA Study. *Med Sci Sports Exerc.* 2015;47(11):2353-2358.
2. Yates T, Davies MJ, Haffner S, et al. Physical activity as a determinant of fasting and 2-h post-challenge glucose: a prospective cohort analysis of the NAVIGATOR trial. *Diabet Med.* 2015;32(8):1090-1096.
3. Wolff-Hughes DL, Fitzhugh EC, Bassett DR, et al. Total activity counts and bouts minutes of moderate-to-vigorous physical activity: relationships with cardiometabolic biomarkers using 2003-2006 NHANES. *J Phys Act Health.* 2015;12(5):694-700.
4. Liu L, Shi Y, Li T, et al. Leisure time physical activity and cancer risk: evaluation of the WHO's recommendation based on 126 high-quality epidemiological studies. *Br J Sports Med.* 2016;50(6):372-378.
5. US Department of Health and Human Services (USDHHS). *Physical Activity Guidelines for Americans*. 2<sup>nd</sup> ed. Washington, DC: USDHHS; 2018.
6. Pate RR, Pratt M, Blair SN, et al. Physical activity and public health: a recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. *JAMA.* 1995;273(5):402-407.
7. US Department of Health and Human Services (USDHHS) 2008 Physical Activity Guidelines Advisory Committee. 2008 physical activity guidelines for Americans. Available at: <https://health.gov/paguidelines/2008/>. Accessed December 23, 2019.
8. Carlson SA, Fulton JE, Schoenborn CA, et al. Trend and prevalence estimates based on the 2008 Physical Activity Guidelines for Americans. *Am J Prev Med.* 2010;39(4):305-313.
9. Tucker JM, Welk GJ, Beyler NK. Physical activity in US adults: compliance with the physical activity guidelines for Americans. *Am J Prev Med.* 2011;40(4):454-461.
10. Visser PL, Hirsch JK. Health behaviors among college students: the influence of future time perspective and basic psychological need satisfaction. *Health Psychol Behav Med.* 2014;2(1):88-99.
11. American College Health Association (ACHA). *American College Health Association-National College Health Assessment II: Reference Group Executive Summary Fall 2017*.

- Hanover, MD: ACHA; 2018.
12. Kay MC, Carroll DD, Carlson SA, et al. Awareness and knowledge of the 2008 Physical Activity Guidelines for Americans. *J Phys Act Health*. 2014;11(4):693-698.
  13. Moore LV, Fulton J, Kruger J, et al. Knowledge of physical activity guidelines among adults in the United States, HealthStyles 2003-2005. *J Phys Act Health*. 2010;7(2):141-149.
  14. Rogers EM. *Diffusion of Innovations*. New York, NY: Simon and Schuster; 2010.
  15. Glanz K, Rimer BK, Viswanath K. *Health Behavior and Health Education: Theory, Research, and Practice*. 3<sup>rd</sup> ed. San Francisco, CA: Jossey-Bass; 2008.
  16. Troiano RP, Berrigan D, Dodd KW, et al. Physical activity in the United States measured by accelerometer. *Med Sci Sports Exerc*. 2008;40(1):181-188.
  17. Freedson PS, Melanson E, Sirard J. Calibration of the Computer Science and Applications, Inc. accelerometer. *Med Sci Sports Exerc*. 1998;30(5):777-781.
  18. Matthews CE, Chen KY, Freedson PS, et al. Amount of time spent in sedentary behaviors in the United States, 2003-2004. *Am J Epidemiol*. 2008;167(7):875-881.
  19. Kohl 3<sup>rd</sup> HW, Craig CL, Lambert EV, et al. The pandemic of physical inactivity: global action for public health. *Lancet*. 2012;380(9838):294-305.
  20. Kolodinsky J, Harvey-Berino JR, Berlin L, et al. Knowledge of current dietary guidelines and food choice by college students: better eaters have higher knowledge of dietary guidance. *J Am Diet Assoc*. 2007;107(8):1409-1413.
  21. Erinoshio TO, Moser RP, Oh AY, et al. Awareness of the fruits and veggies - More Matters campaign, knowledge of the fruit and vegetable recommendation, and fruit and vegetable intake of adults in the 2007 Food Attitudes and Behaviors (FAB) Survey. *Appetite*. 2012;59(1):155-160.
  22. Plotnikoff RC, Lippke S, Trinh L, et al. Protection motivation theory and the prediction of physical activity among adults with type 1 or type 2 diabetes in a large population sample. *Br J Health Psychol*. 2010;15(3):643-661.
  23. Prentice-Dunn S, Rogers RW. Protection motivation theory and preventive health: Beyond the health belief model. *Health Educ Res*. 1986;1(3):153-161.
  24. Weinstein ND. The precaution adoption process. *Health Psychol*. 1988;7(4):355-386.
  25. Wong F, Huhman M, Asbury L, et al. VERB™ - a social marketing campaign to increase physical activity among youth. *Prev Chronic Dis*. 2004;1(3):A10.
  26. Cleeman JI, Lenfant C. The National Cholesterol Education Program: progress and prospects. *JAMA*. 1998;280(24):2099-2104.
  27. Han H, Gabriel KP, Kohl III HW. Application of the transtheoretical model to sedentary behaviors and its association with physical activity status. *PLoS One*. 2017;12(4):e0176330.
  28. Whitfield G, Gabriel KKP, Kohl HW. Sedentary and active: self-reported sitting time among marathon and half-marathon participants. *J Phys Act Health*. 2014;11(1):165-172.
  29. Owen N, Healy GN, Matthews CE, et al. Too much sitting: the population-health science of sedentary behavior. *Exerc Sport Sci Rev*. 2010;38(3):105-113.
  30. Carlson SA, Fulton JE, Schoenborn CA, et al. Trend and prevalence estimates based on the 2008 Physical Activity Guidelines for Americans. *Am J Prev Med*. 2010;39(4):305-313.



Copyright of Health Behavior & Policy Review is the property of Paris Scholar Publishing and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.