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Personalizing mobile-health Apps using reinforcement learning to increase physical activity among nursing students: A feseable study

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Abstract

Background: Applying a health-App might suitable in the context of nursing students in Indonesia.
Purpose: This study was conducted an interactive smartphone Apps and social media for nursing students to determine the role of the Internet-delivered program as a media to promoting physical activity.
Method: A non-equivalent control group with pre and post-test design included 80 nursing students with physical inactive by sample power to estimated, and recruited from the nursing university. The eligible participants were randomly assigned to intervention or control group. The intervention group received education session and mobile student activity reinforcement combine with social media during 12-week, and control group received usual care. PA was measured using the health-app and self-efficacy were assessed through extensive questionnaire. Data was analyzed within and between intervention and control groups to assess long-term effects using t-tests, ANOVAs and linier regression.
Results: The primary outcome of the recommended levels of PA, there was a significant reduction after 12-week of intervention, and significant difference between the groups was observed. The secondary outcomes, there was a significant increase in self-efficacy in both groups, and significant difference between groups.
Conclusion: The intervention was successfully promoted PA of Indonesian-nursing students over 12-week. The intervention was designed to be simple for widespread implementation in a variety of nursing students and settings, as it requires no special equipment or previous PA knowledge.

Keywords: Smartphone Apps; Physical activity, Self-efficacy; Nursing students

INTRODUCTION

Physically inactivity in nursing students is one of the most serious public health challenges of the 21st century worldwide that is considered to be a behavioral health risk (Lee et al., 2012; WHO, 2018). The negative impacts of physically inactive includes weight gain (Deliens et al., 2015; LaCaille, Dauner, Krambeer, & Pedersen, 2011; Nelson, Story, Larson, Rauner, Mess, & Woll, 2013; Söderlund, Fischer, & Johansson, 2009), increase the risk of developing non-communicable diseases such as cardiovascular disease (Chomistek et al., 2013; Lee et al., 2012), and diabetes (Kyu et al., 2016; Wilmot et al., 2012).

Previous systematic review found that the app-based interventions migth effective to promote physical activity (PA) and multicomponent interventions appear to be more effective than stand-alone app interventions (Schoeppe et al., 2016). However, there is a lack of randomized trials, and most previous studies have included older populations (Muellmann, Forberger, Möllers, Bröring, Zeeb, & Pischke, 2018) or relied on self-reported measures of PA (Schoeppe et al., 2016). The discrepancy between self-reported and objectively measured PA is well established

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(Schuna, Johnson, & Tudor-Locke, 2013), and several app-based PA intervention studies show substantial increases in self-reported PA but not objectively (accelerometer) measured PA (Marsaux et al., 2015; Wanner, Martin-Diener, Braun-Fahrländer, Bauer, & Martin, 2009). This lack of uniformity, in combination with the inaccuracy of self-reported data as a measure of PA, makes it difficult to compare and summarize outcomes across PA interventions.

Early use of technology, such as use of computers, i.e. websites, or mobile phones with short text message services, has been shown to have positive effects on the level of physical activity in university students (Hamari, Koivisto, & Sarsa, 2014; Hswen, Murti, Vormawor, Bhattacharjee, & Naslund, 2013). However, with the rapid technology development of today, smartphone-applications (apps) are now available for large-scale use. Smartphone technology and mobile applications have shown promising results in PA and health promotion (Ozdalga, Ozdalga, & Ahuja, 2012; Fanning, Mullen, & McAuley, 2012; Kirwan, Duncan, Vandelanotte, & Mummery, 2012; King et al., 2013). Of the 875,683 active Apps available in iTunes and the 696,527 active Apps in Google Play, 23,490 and 17,756 were categorized as health and fitness (Middelweerd, Mollee, van der Wal, Brug, & Te Velde, 2014; Jee, 2017). Apps designed based on the behavioral changes theory, in which users will receive a motivational message, predefined goal set up, daily feedback, percent of an archived goal, and can share their information to other through social media such as Facebook and MyFitnessPal (Hamari, Hassan, & Dias, 2018; Al Ayubi, Parmanto, Branch, & Ding, 2014). In Indonesia, over 100 millions people have smartphone and ownership (Kementrian Komunikasi dan Informatika Republik Indonesia, 2019). Use of new technology could be a way to reach large numbers of nursing students.

Applying a health-App might suitable in the context of nursing students in Indonesia. However, there is no culturally tailored reinforcement learning by self-efficacy program to improve physical activity, and health outcomes among nursing students in the university. Therefore, this study is urgent need to know the impact will be having on users. Recent study was conducted a physical activity intervention through an interactive smartphone Apps and social media for nursing students to determine the role of the Internet-delivered program as a media to promoting physical activity.

RESEARCH METHODS

A quasi-experimental study with pre-test and post-test design was used to evaluate the effectiveness of personalizing mobile health apps using reinforcement learning to increase physical activity among nursing students.

Participants

Convenience sampling was applied to obtain a sample that adequately represents the target population are nursing students in Bandung with an estimated around 6,000 Students. Recruitment started in May 2020, and the last 12 weeks measurements were finished in August 2020. The eligiblity criteria comprised the following: both gender, aged with 20 years or above, nursing students in bachelor degree, who reported having experienced any mobility-related problems affecting their everyday life before enrollment in this study. Participants who were bound to a wheelchair or whose medical condition prevented them from moderate-intensity walking, as well as people unable to speak and read Bahasa Indonesia or who did not have access to a smartphone, were excluded.

G*Power software version 3.1.9.2 was used to carry out the sample size with the confidence level of 95%, confidence interval of 9.81, the power of 0.80, the effect size of 0.25 (Sriramatr et al., 2014), and an alpha level of 0.05 were set for the main and interaction effects. The 80 participants was required. A number of 40 participants in each group was required after sample size calculation.

Instrumen

Physical activity (Primary Outcome)

Outcomes was measured at baseline and at

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16-weeks. The primary outcome physical activity was used International Physical Activity Questionnaire short form (IPAQ-SF). Participants were reported frequency of physical activity performed during the last 7 days and the duration (minutes/hours usually spent on one of those days). The report activities include their vigorous-intensity physical activity, moderate-intensity physical activity, and walking. The range of physical activity needs to report at least 10 minutes.

Participants also report the total time that they spent sitting in a weekday, during at the last 7 days (Group, 2005). IPAQ was validated in 12 countries. The short version of the IPAQ was found to have acceptable test-retest reliability using pooled Spearman's (ρ =0.75). The IPAQ short questionnaire has reliability 75 % of the correlation coefficients above 0.65 and ranging from 0.88 to 0.32. Overall, the pooled ρ was 0.76 (95% CI 0.73–0.77). Criterion validity was 0.67 (95% CI 0.64–0.70) and for comparisons of different short instruments was 0.58 (0.51–0.64) (Craig et al., 2003).

Secondary outcome

Anthropometric evaluation

In anthropometric evaluation, participants were asked to remove shoes while height was measured to the nearest 0.1 cm. Weight and height were measured using a portable stadiometer, in the standing position, without shoes and record to the nearest millimeter (Gibson, 2005). The anthropometric measurements indices was calculate: body mass index (BMI) reach by dividing the weight (kg) by the height (m) squared. The World Health Organization classification of the BMI (weight/height^2; (kg/m^2)) was used to classify underweight, normal-weight, overweight and obesity in the studied population (WHO, 2000).

Blood pressure measurement

Blood pressure was measured by a registered nurse using a validated and calibrated digital automated sphygmomanometer, after the participant had rested for at least 15 minutes (El Assaad, Topouchian, Darne, & Asmar, 2002). Two consecutive measurements were obtain 5-minutes apart and the average of the two readings were recorded (Pickering et al., 2005).

Assessment of Exercise self-efficacy

Exercise self-efficacy in Bahasa Indonesia version (ESE-I) is defined as participants' confidence in their ability to exercise regularly (most days of the week). In this study, Exercise self-efficacy in Bahasa Indonesia version was assessed with the self-administered an 18-item exercise self-efficacy (ESE) scale developed by Bandura (2005). In the first time, ESE was asked participants to rate perform exercise routine per week (three or more times per week), for a range of conditions. The ESE was require participant to rate the strength of their belief in current capabilities to do a specific activity at the time of the measurement. Scales can be from 0 to 100 with increments of 10 or from 1 to 10 depending on the age and ability of participants. The scale ranged from 0 (I cannot do this activity at all) to 10 (I am certain that I can do this activity successfully)." A 5 interval scale is weaker than using a 0- 100 scale because it does not allow responses to be distributed over a range.

The ESE scale was demonstrated robust evidence of reliability (Cronbach's alpha 0.917), high internal consistency (0.95), and validity (correlation with minutes of exercise per week [r = 0.41; *P*< 0.0001] and health status [r = 0.37; *P*< 0.0001] (Davis et al., 2012).

Data Collection Procedure

After giving informed consent from each respondent, the experimental study was processed in 12 weeks. In the first visit, the researchers were explained purposes of this study and give anelectronic booklet for providing physical activity (PA) related knowledge. Self-administrated structured questionnaires were used to collect data within 30 minutes that include social demographics, self-efficacy exercise, and the PA performances. Regarding the objective measures for level of physical activity in one week, it was

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collected by smartphone health-app for 7 days. The physical anthropometrics including height and weight were measured by a valid electronic stadiometer, and automated sphygmomanometer for blood pressure.

Researchers was send all physical activity information by social media approaches. The outcomes measurements were assessed before and after the intervention program for participants. After pretest, respondents in the intervention group were additionally received one-50 minutes' instruction according to a guideline for learning to use the smartphone health-app to collect the PA and smartphone health-app with reinforcement learning by self-efficacy program during 12 weeks. Regarding ethics issues, ID and password were set by each user through the smartphone app to review individual PA information. For the social media competition game, 26 teams of 4 members were created in the intervention group based on friendship. Participants in the control group were received usual care.

Data analysis

Analysis was performed using SPSS 23th version. Descriptive statistic were analyzed demographics, health beliefs and the behavior. Paired T-test was compared means variables within group. Demographic characteristics and baseline measures were compared at baseline using chi-square test and pair t-test. Changes from pretest to posttest in outcome variables were calculated. Four multivariate ANCOVAs, with the baseline scores serving as covariates, were used to measure differences in physical activity between the groups after 12 weeks. All the tests were conducted at α of 0.05. If the *p*-value ≤ 0.05, the analyzed data were considered statistically significant.

Ethical consideration

The Ethics Committee of the Ethics Review Board of the Local Government (Ref: 423.4/0012/wasbang/2020) approved the present study. All participants were provided a consent form and given the assurance of data confidentiality and privacy.

RESULT

Study Participants and Smartphone Health-Apps Intervention Adherence

In total, 80 nursing students were participated in this study. The participants' ages ranged from 22 to 25 years, 23.8 years being the average. The average weight and BMI of participants were 86.86 kg and 25.9 kg/m2, respectively. There were no significant differences between the intervention and control groups in any of the demographic, physical activity, and self-efficacy variables at pretest (all p > .05, see Table 1 and Table 2).

A total of 37.5% (15/40) nursing students in the intervention group used the smartphone apps daily, 27.5% (11/40) for 5 to 6 days/week, 20% (8/40) for 3 to 4 days/week, and 15% (6/40) for less than 3 times/week.

Baseline Characteristics

Baseline characteristics of the participants are shown in Table 1. A series of intervention or control between-groups were showed no significant with regard to baseline characteristics. A majority of the nursing students were not met with physical activity recommended (at least 150 min of MVPA/week).

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Table 1 Based Line Social Demographics And Family History

Variable	Group	Total	Exp. (n=40)	CN (n= 40)	*p*-value
			n, %		
Gender (n,%)	Male	36	17 (42.5)	19 (47.5)	**0.78**
	Female	44	23 (57.5)	23 (52.5)	
Age (Mean ±SD)		80	22.67(2.37)	23.16(2.46)	**0.57**
Religion (n,%)	Islam	28	16 (40)	12 (30)	**0.69**
	Others	42	24 (60)	28 (70)	
Family History of DM (n,%)	Yes	20	11 (27.5)	9 (22.5)	**0.83**
	No	60	29 (72.5)	31 (77.5)	

The final sample included a total of 80 participants (36 female, 44 male) and the mean ages in intervention group was 23.16 (SD= 1.71) and the control group (M = 22.46; SD= 1.46). Attrition was low (n=8), and was solely attributed to app or mobile phone malfunctions. Descriptive statistics for each condition can be found in Table 1-2. Results of an independent samples t-test showed that there was no significant difference between daily step counts, distance walked, achieve recommended level of PA, BMI, systolic blood pressure, and SE of the control and experimental groups at baseline (P ≥ 0.05), ensuring that randomization was effective.

Table 2. Physical Activity Behavior self-efficacy and Health outcomes in Pre-test

Variable	Overall (Mean, SD)	Exp. (n=40)	CN (n= 40)	Diff. Mean (CI 95%)	*p*-value
		Mean (SD)			
PA Behavior					
Total weekly steps	33763.39 (7541.48)	34270.58 (6759.85)	33302.09 (8349.46)	769.70 (32235.34 – 35381.43)	0.495
Total days achieve 10000 steps	.0000	.00000	.00000	.0000	0.000
Distances	22.37 (5.61)	21.87 (4.72)	22.72 (6.48)	0.74 (21.14 – 23.41)	0.581
Self-Efficacy	77.22 (28.68)	77.72 (28.13)	76.61 (29.50)	1.11 (72.42 - 84.04)	0.597
Health Outcomes					
Systolic Blood Pressure	120.03 (13.48)	119.00 (12.74)	121.15 (14.29)	2.15 (117.30 – 122.76)	0.429
Diastolic Blood Pressure	73.07 (9.34)	74.12 (9.33)	71.93 (9.10)	2.19 (71.20 – 74.94)	0.250
BMI (kg/m^{2})	86.86 (11.44)	85.34 (12.30)	88.52 (10.31)	3.18 (84.55 – 89.18)	0.178

Changes in Outcomes From Baseline to 12 weeks Between-Group

Between-group differences at 12 weeks in the primary and secondary outcomes were shown in Table 3. The significant differences were found between the groups for any of the outcomes at 12 weeks, except for body weight and BMI. A total of 90% (36/40) of participants in the smartphone health-app, met the PA recommendations at 12 weeks.

For the primary outcome of the recommended levels of physical activity, there was a significant

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reduction after 12 weeks of intervention, and significant difference between the groups was observed. The intervention group recorded more steps/day ($p < 0.000$, eta = 0.59), greater achieve recommended level of PA ($p < 0.000$, eta = 0.59), greater distances walked ($p < 0.000$, eta = 0.61), and lower systolic blood pressure ($p < 0.006$, eta = 0.18) than the control group participants. No main effects of the intervention were observed on diastolic blood pressure ($p > 0.05$, eta = 0.03) and BMI ($p > 0.05$, eta = 0.03). With respect to the secondary outcomes, there was a significant increase in self-efficacy in both groups, and significant difference between the treatment groups.

Table 3. Treatment effects at 12 weeks

Factors	Variable	Group	Pre-test Mean (SD)	Posttest Mean (SD)	Adjusted diff. mean	Adjusted diff. mean (CI 95%)	F	P-value	Partial-eta squared
Physical Activity Behavior	Total weekly steps	Exp.	34260.58 (6759.85)	70856.32 (13822.98)	30484.08	25329.67 – 35638.49	138.01	0.000	0.59
		CN	33202.09 (8349.46)	41006.13 (9855.19)					
	Total days achieve 10000 steps	Exp.	0.00 (0.00)	3.22 (1.62)	2.91	2.35 – 3.47	107.59	0.000	0.57
		CN	0.00 (0.00)	0.35 (0.79)					
	Distances (steps/km)	Exp.	21.97 (4.72)	47.34 (11.41)	20.32	16.40 – 24.24	106.01	0.000	0.61
		CN	22.61 (6.48)	27.22 (5.33)					
Self-Efficacy		Exp.	79.72 (28.13)	95.36 (28.32)	11.85	1.64 – 22.05	5.32	0.023	0.04
		CN	76.61 (29.50)	86.17 (30.58)					
Health Outcomes	Systolic Blood Pressure (mmHg)	Exp.	119.00 (12.74)	116.00 (10.12)	-4.96	-8.40 – -1.52	8.22	0.006	0.18
		CN	121.15 (14.29)	120.67 (11.36)					
	Diastolic Blood Pressure (mmHg)	Exp.	74.12 (9.33)	73.98 (8.96)	-5.05	-7.96 – -2.71	12.35	0.071	0.03
		CN	74.93 (9.40)	74.10 (9.13)					
	BMI (kg/m^2)	Exp.	85.34(10.31)	79.98(11.63)	-5.97	-7.40 – -4.54	69.02	0.067	0.03
		CN	88.52 (12.30)	89.07(10.26)					

DISCUSSION

This study is pioner study which used smartphone health monitor app in combination with social media group competition as a tool to promote PA in Indonesia. Overall, the personalizing mobile health apps using reinforcement learning was successful increased physical activity in nursing students with medium effects. The personalizing mobile health apps using reinforcement learning had significant effects on the number of steps/day, distance walked, calories consumption, and duration of physical activity. However, this association is stronger for higher-intensity physical activity. Participants in the current study could participate in the PA of their own choosing and were asked to increase duration PA by 150 minutes per week in moderate level. However, the increase in PA might still have influenced health outcomes, particularly in the area of metabolic fitness, an area for future studies.

Further studies is required to determine how to maintain recommended level of PA in the longer times. Previous studies suggested that the apps may useful to maintain physical activity in the recommended level in long-term folluw-up (Feldsoe et al., 2011). While the study's intervention was mainly guided by the theory of planned behavior, other behavior change theories

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which emphasize behavior maintenance, such as the transtheoretical model (Prochaska & Velicer, 1997) or the health action process approach, and self-regulation theories (Maes & Karoly, 2005), may provide valuable insights into further strategies to maintain behavior changes in the longer term. The success of the intervention in changing behavior and social cognitive theory (SCT) variables is as reported by some previous studies on university students (Mirzaei-Alavijeh et al., 2018; Wadsworth, & Hallam, 2010; Davies, Spence, Vandelanotte, Caperchione, & Mummery, 2012). An SCT-based Internet intervention was found to be a useful tool in the PA promotion of Indonesian nursing students. This study found that the number of steps/day of the participants in the control group remained at the low-end of step recommendation (i.e., < 7500) (Tudor-Locke, Craig, Thyfault, & Spence, 2012).

Recent study were neither given any information or access to interactive features after the intervention period. The lack of contact with participants during follow-up could have some effect to decrease physical activity levels (Marcus et al., 2000). Physical activity relapse in previous studies might have occurred because most the existing web-based programs were not interactive enough during the intervention period to engage the participants fully (Carr et al., 2008; Linke et al., 2019). Future studies should examine the influence of continued post-intervention contact or website access on the maintenance of PA.

This study highlights possible cross-cultural considerations for using SCT and the Internet to promote PA. The influence of the Indonesian culture might partially explain PA maintenance during intervention period. Cultural background and experiences can influence one's self; people's way of living, thinking, and behaving is influenced by culture (Markus, & Kitayama, 1991; Lim, Waters, Froelicher, & Kayser-Jones, 2008). People in Western countries are more likely to be independent (behavior is organized primarily by reference to one's own thoughts, feelings, and actions), whereas people in Asian countries are more likely to be interdependent (behavior is determined by the perceived thoughts, feelings, and actions of others) (Markus, & Kitayama, 1991). The interdependency of Indonesian nursing students may have a role in PA promotion, as corroborated by the low attrition rate of ~21% in this study in comparison to previous Western studies (~30%) (Vandelanotte et al., 2007; Davies et al., 2012). Therefore, the interdependency in Indonesian nursing students may have a stronger influence on self-efficacy than in Western students who may be more independent. However, the influence of culture on starting and maintaining PA was not examined in this study; thus, this suggestion needs verification, and future studies should examine the specific influence of culture on the self-efficacy PA programs.

A major strength of this study was significant in methodological and theoretical strength including the use of an time-cluster randomized design as well as SCT in developing the interactive program to determine the effect of the use of commercially available apps to increase physical activity. Use of the apps during the intervention was ad libitum and not closely monitored, which reflects real-life app use, and contact with participants in the app group was minimal to reflect a real-world context and therefore increase generalizability. Furthermore, the primary and secondary outcomes were measured with objective measurements, in accordance with current recommendations for evaluating the effectiveness of PA interventions (Silfee et al., 2018).

Some limitations of current study should be recognized. The participants in this study were self-recruited from the nursing institutions; they may not be fully representative of all nursing students in university. Using free apps maigth have increased contamination and/or co-interventions. Participants were aware of the study when they performed the baseline measurements of PA, it is most likely that they were more physically active than usual, which limits the comparison of baseline and outcome for PA measures. Future studies should confirm these findings with other Indonesian population groups and include a measurement of the intensity of the activity undertaken.

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CONCLUSION

The smartphone health monitor app in combination with social media program was successfully promoted PA of Indonesian nursing students over 12 weeks. The app intervention was designed to be simple for widespread implementation in a variety of nursing students and settings, as it requires no special equipment or previous physical activity knowledge. Although apps have the potential to increase the reach of health behavior change interventions, our results mirror the recent study showing that few individuals will use an offered app consistently over time. Given the high degree of smartphone use in the nursing students, the fact that an app-based intervention has the potential to increase reach at a low cost and the substantial health effects associated w1 an increased physical activity and self-efficacy. However, the intervention should be tested in a variety of population groups over a longer period before wide scale implementations.

CONFLICTS OF INTEREST

The authors declared that no conflict of interest.

REFERENCES

Al Ayubi, S. U., Parmanto, B., Branch, R., & Ding, D. (2014). A persuasive and social mHealth application for physical activity: a usability and feasibility study. *JMIR mHealth and uHealth*, 2(2), e25.

Bandura, A. (2005). The primacy of self- regulation in health promotion. *Applied Psychology*, 54(2), 245- 254.

Carr, L. J., Bartee, R. T., Dorozynski, C., Broomfield, J. F., Smith, M. L., & Smith, D. T. (2008). Internet-delivered behavior change program increases physical activity and improves cardiometabolic disease risk factors in sedentary adults: results of a randomized controlled trial. *Preventive medicine*, 46(5), 431-438. https://doi.org/10.1016/j.ypmed.2007.12.005

Chomistek, A. K., Manson, J. E., Stefanick, M. L., Lu, B., Sands-Lincoln, M., Going, S. B., ... & Johnson, K. C. (2013). Relationship of sedentary behavior and physical activity to incident cardiovascular disease: results from the Women's Health Initiative. *J Am Coll Cardiol*, 61(23), 2346-2354. http://dx.doi.org/10.1016%2Fj.jacc.2013.03.031

Craig, C. L., Marshall, A. L., Sjostrom, M., Bauman, A. E., Booth, M. L., Ainsworth, B. E., Oja, P. (2003). International physical activity questionnaire: 12-country reliability and validity. *Med Sci Sports Exerc, 35*(8), 1381-1395. http://dx.doi.org/10.1249/01.MSS.0000078924.61453.FB

Davies, C. A., Spence, J. C., Vandelanotte, C., Caperchione, C. M., & Mummery, W. K. (2012). Meta-analysis of internet-delivered interventions to increase physical activity levels. *Int J Behav Nutr Phys Act*, 9(1), 52. https://doi.org/10.1186/1479-5868-9-52

Deliens, T., Deforche, B., De Bourdeaudhuij, I., & Clarys, P. (2015). Determinants of physical activity and sedentary behaviour in university students: a qualitative study using focus group discussions. *BMC Public Health*, 15(1), 1.

El Assaad, M. A., Topouchian, J. A., Darne, B. M., & Asmar, R. G. (2002). Validation of the Omron HEM-907 device for blood pressure measurement. *American Journal of Hypertension*, 15(S3), 87A-87A. https://doi.org/10.1097/00126097-200208000-00006

Fanning, J., Mullen, S. P., & McAuley, E. (2012). Increasing physical activity with mobile devices: a meta-analysis. *J Med Internet Res*, 14(6). https://doi.org/10.2196/jmir.2171

Fjeldsoe, B., Neuhaus, M., Winkler, E., & Eakin, E. (2011). Systematic review of maintenance of behavior change following physical activity and

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DOI: https://doi.org/10.33024/minh.v4i1.3492

dietary interventions. *Health Psychology*, 30(1), 99. https://doi.org/10.1037/a0021974

Gibson, R. S. (2005). Principles of nutritional assessment: Oxford university press, USA.

Group, I. P. A. Q. (2005). Guidelines for Data Processing and Analysis of the International Physical Activity Questionnaire (IPAQ). Available on https://sites.google.com/site/theipaq/

Hamari, J., Koivisto, J., & Sarsa, H. (2014, January). Does gamification work?--a literature review of empirical studies on gamification. In 2014 47th Hawaii international conference on system sciences (pp. 3025-3034). http://dx.doi.org/10.1109%2FHICSS.2014.377

Hamari, J., Hassan, L., & Dias, A. (2018). Gamification, quantified-self or social networking? Matching users' goals with motivational technology. *User Modeling and User-Adapted Interaction*, 28(1), 35-74. http://dx.doi.org/10.1007/s11257-018-9200-2

Hswen, Y., Murti, V., Vormawor, A. A., Bhattacharjee, R., &Naslund, J. A. (2013). Virtual avatars, gaming, and social media: Designing a mobile health app to help children choose healthier food options. *J Mob Technol Med*, 2(2), 8. https://doi.org/10.7309/jmtm.2.2.3

Jee, H. (2017). Review of researches on smartphone applications for physical activity promotion in healthy adults. *J Exerc Rehabil*, 13(1), 3-11. https://doi.org/10.12965/jer.1732928.464

Kementrian Komunikasi dan Informatika Republik Indonesia. (2019). Indonesia raksasa teknologi digital Asia. Available from: https://kominfo.go.id/content/detail/6095/indonesia-raksasa-teknologi-digital-asia/0/sorotan_media

King, A. C., Hekler, E. B., Grieco, L. A., Winter, S. J., Sheats, J. L., Buman, M. P., ... & Cirimele, J. (2013). Harnessing different motivational frames via mobile phones to promote daily physical activity and reduce sedentary behavior in aging adults. *PloS one*, 8(4), e62613. https://doi.org/10.1371/journal.pone.0062613

Kirwan, M., Duncan, M. J., Vandelanotte, C., & Mummery, W. K. (2012). Using smartphone technology to monitor physical activity in the 10,000 Steps program: a matched case–control trial. Journal of medical Internet research, 14(2), e55. https://doi.org/10.2196/jmir.1950

Kyu, H. H., Bachman, V. F., Alexander, L. T., Mumford, J. E., Afshin, A., Estep, K., ... & Cercy, K. (2016). Physical activity and risk of breast cancer, colon cancer, diabetes, ischemic heart disease, and ischemic stroke events: systematic review and dose-response meta-analysis for the Global Burden of Disease Study 2013. *BMJ*, 354, i3857. https://doi.org/10.1136/bmj.i3857

LaCaille, L. J., Dauner, K. N., Krambeer, R. J., & Pedersen, J. (2011). Psychosocial and environmental determinants of eating behaviors, physical activity, and weight change among college students: a qualitative analysis. *Journal of American College Health*, 59(6), 531-538. https://doi.org/10.1080/07448481.2010.523855

Lee, I. M., Shiroma, E. J., Lobelo, F., Puska, P., Blair, S. N., &Katzmarzyk, P. T. (2012). Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy. *The Lancet*, 380(9838), 219-229. https://doi.org/10.1016/s0140-6736(12)61031-9

Lim, K. C., Waters, C. M., Froelicher, E. S., & Kayser-Jones, J. S. (2008). Conceptualizing physical activity behavior of older Korean-Americans: An integration of Korean culture

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and social cognitive theory. *Nursing outlook*, 56(6), 322-329. https://doi.org/10.1016/j.outlook.2008.09.001

Linke, S. E., Dunsiger, S. I., Gans, K. M., Hartman, S. J., Pekmezi, D., Larsen, B. A., ... & Marcus, B. H. (2019). Association between physical activity intervention website use and physical activity levels among Spanish-speaking Latinas: randomized controlled trial. *J Med Internet Res*, 21(7), e13063. http://doi.org/10.2196/13063

Maes, S., & Karoly, P. (2005). Self-regulation assessment and intervention in physical health and illness: A review. *Applied psychology*, 54(2), 267-299. https://doi.org/10.1111/j.1464-0597.2005.00210.x

Markus, H. R., & Kitayama, S. (1991). Culture and the self: Implications for cognition, emotion, and motivation. *Psychological review*, 98(2), 224. https://psycnet.apa.org/doi/10.1037/0033-295X.98.2.224

Marcus, B. H., Forsyth, L. H., Stone, E. J., Dubbert, P. M., McKenzie, T. L., Dunn, A. L., & Blair, S. N. (2000). Physical activity behavior change: issues in adoption and maintenance. Health psychology, 19(1S), 32. https://doi.org/10.1037/0278-6133.19.suppl1.32

Marsaux, C. F., Celis-Morales, C., Fallaize, R., Macready, A. L., Kolossa, S., Woolhead, C., & Lambrinou, C. P. (2015). Effects of a web-based personalized intervention on physical activity in European adults: a randomized controlled trial. *J Med Internet Res*, 17(10), e231. https://doi.org/10.2196/jmir.4660

Middelweerd, A., Mollee, J. S., van der Wal, C. N., Brug, J., & Te Velde, S. J. (2014). Apps to promote physical activity among adults: a review and content analysis. *Int J Behav Nutr Phys Act*, 11(1), 97. https://doi.org/10.1186/s12966-014-0097-9

Mirzaei-Alavijeh M, Soroush A, Nasirzadeh M, Hatamzadeh N, Zinat-Motlagh F, Jalilian F, et al. (2017). Socio-Cognitive Ministry of Communication and Information Technology. Annual reports 2017. Ministry of Communication and Information Technology; 2017 [cited 2020 August 14]. Available from https://web.kominfo.go.id/sites/default/files/KOMINFO_Laptah%202017_Final_English.pdf

Muellmann, S., Forberger, S., Möllers, T., Bröring, E., Zeeb, H., & Pischke, C. R. (2018). Effectiveness of eHealth interventions for the promotion of physical activity in older adults: A systematic review. Prev Med, 108, 93-110. https://doi.org/10.1016/j.ypmed.2017.12.026

Nelson, M. C., Story, M., Larson, N. I., Neumark-Sztainer, D., & Lytle, L. A. (2008). Emerging adulthood and college-aged youth: an overlooked age for weight-related behavior change. *Obesity*, 16(10),2205. https://doi.org/10.1038/oby.2008.365

Ozdalga, E., Ozdalga, A., & Ahuja, N. (2012). The smartphone in medicine: a review of current and potential use among physicians and students. *J Med Internet Res*, 14(5), e128. https://doi.org/10.2196/jmir.1994

Pickering, T. G., Hall, J. E., Appel, L. J., Falkner, B. E., Graves, J., Hill, M. N., & Roccella, E. J. (2005). Subcommittee of Professional and Public Education of the American Heart Association Council on High Blood Pressure Research. Recommendations for blood pressure measurement in humans and experimental animals: Part 1: blood pressure measurement in humans: a statement for professionals from the Subcommittee of Professional and Public Education of the American Heart Association Council on High Blood Pressure Research. *Hypertension*, 45(1), 142-161.

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https://doi.org/10.1161/01.hyp.0000150859.47929.8e

Prochaska JO, Velicer WF. (1997). The transtheoretical model of health behavior change. *Am J Health Promot*. 12(1),38-48. https://doi.org/10.4278%2F0890-1171-12.1.38

Rauner, A., Mess, F., & Woll, A. (2013). The relationship between physical activity, physical fitness and overweight in adolescents: a systematic review of studies published in or after 2000. *BMC pediatrics*, 13(1), 19. https://doi.org/10.1186/1471-2431-13-19

Schoeppe, S., Alley, S., Van Lippevelde, W., Bray, N. A., Williams, S. L., Duncan, M. J., & Vandelanotte, C. (2016). Efficacy of interventions that use apps to improve diet, physical activity and sedentary behaviour: a systematic review. *Int J Behav Nutr Phys Act*, 13(1), 127. https://doi.org/10.1186/s12966-016-0454-y

Schuna, J. M., Johnson, W. D., & Tudor-Locke, C. (2013). Adult self-reported and objectively monitored physical activity and sedentary behavior: NHANES 2005–2006. *Int J Behav Nutr Phys Act*, 10(1), 126. https://doi.org/10.1186/1479-5868-10-126

Silfee, V. J., Haughton, C. F., Jake-Schoffman, D. E., Lopez-Cepero, A., May, C. N., Sreedhara, M., & Lemon, S. C. (2018). Objective measurement of physical activity outcomes in lifestyle interventions among adults: A systematic review. *Prev Med Rep*, 11, 74-80. https://doi.org/10.1016/j.pmedr.2018.05.003

Söderlund, A., Fischer, A., & Johansson, T. (2009). Physical activity, diet and behaviour modification in the treatment of overweight and obese adults: a systematic review. *Perspectives in Public Health*, 129(3), 132-142. https://doi.org/10.1177/1757913908094805

Sriramatr, S., Silalertdeskul, S., & Wachirathanin, P. (2016). Social cognitive theory associated with physical activity in undergraduate students: A cross-sectional study. *Pacific Rim International Journal of Nursing Research*, 20(2), 95-105. available from https://he02.tci-thaijo.org/index.php/PRIJNR/article/view/41039

Tudor-Locke, C., Craig, C. L., Thyfault, J. P., & Spence, J. C. (2013). A step-defined sedentary lifestyle index:< 5000 steps/day. *Applied physiology, nutrition, and metabolism*, 38(2), 100-114. https://doi.org/10.1139/apnm-2012-0235

Vandelanotte, C., Spathonis, K. M., Eakin, E. G., & Owen, N. (2007). Website-delivered physical activity interventions: A review of the literature. *Am J Prev Med*, 33(1), 54-64. https://doi.org/10.1016/j.amepre.2007.02.041

Wadsworth, D. D., & Hallam, J. S. (2010). Effect of a web site intervention on physical activity of college females. *Am J Health Behav,* 34(1), 60-69. https://doi.org/10.5993/ajhb.34.1.8

Wanner, M., Martin-Diener, E., Braun-Fahrländer, C., Bauer, G., & Martin, B. W. (2009). Effectiveness of active-online, an individually tailored physical activity intervention, in a real-life setting: randomized controlled trial. *J Med Internet Res*, 11(3), e23. https://doi.org/10.2196/jmir.1179

Wilmot, Emma G., Charlotte L. Edwardson, Felix A. Achana, Melanie J. Davies, Trish Gorely, Laura J. Gray, Kamlesh Khunti, Thomas Yates, and Stuart JH Biddle. (2012)."Sedentary time in adults and the association with diabetes, cardiovascular disease and death: systematic review and meta-analysis." *Diabetologia*,55(11),2895-2905. https://doi.org/10.1007/s00125-012-2677-z

World Health Organization. (2018). Global health observatory (GHO) data. Available form: http://www.who.int/gho/tb/en

World Health Organization. (2000). Obesity: preventing and managing the global epidemic: World Health Organization. Available from https://www.who.int/nutrition/publications/obesity/WHO_TRS_894/en/

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