Revista de Psicología del Deporte. 2017, Vol 27, Suppl 1, pp. 89-95
Journal of Sport Psychology 2017, Vol 27, Suppl 1, pp. 89-95
ISSN: 1132-239X
ISSNe: 1988-5636

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Universitat Autònoma de Barcelona

Smartphone Applications Used for Initiating and Maintaining Physical Activity: An Exploratory Analysis

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SMARTPHONE APPLICATIONS USED FOR INITIATING AND MAINTAINING PHYSICAL ACTIVITY: AN EXPLORATORY ANALYSIS

KEYWORDS: smartphones; applications; physical activity, motivation.

ABSTRACT: The aim of this study was to explore the degree to which smartphone-based fitness applications help people start and maintain a regular physical activity across North America, South America and Europe. This descriptive and exploratory study consisted of 904 respondents from three continents. A survey composed of demographic questions, closed questions, and scales with Likert-type responses was developed and distributed via social media. Findings revealed that 52.3% of the participants in South America, 72.7% in North America, and 80.1% in Europe had downloaded a physical activity app on their smartphones. Of these participants, 8.1% in South America, 5.9% in North America, and 1.9% in Europe reported that the application helped them very much in beginning an exercise regimen. Similarly, 8.9% from North America, 6.9% from Europe, and 7.1% from South America reported that it helped them very much to maintain their already implemented exercise regimen. The findings revealed that fitness applications for smartphones have limited effect on exercise engagement; for the majority who download them, the apps remain unused, and at this stage did not become part of their internal state of mind.

Physical activity is defined as bodily movement that requires energy expenditure and includes physical activities done as part of daily living, occupation, leisure, exercise, and sports (Tenenbaum, Eklund and Kamata, 2011; World Health Organization, 2016). Physical inactivity has been identified as the fourth leading risk factor for premature death around the world, accounting for slightly over 3 million deaths annually (Middelweerd et al., 2014; World Health Organization, 2016).

Hallal et al. (2012) reported that 31% of adults aged 15 years and older worldwide (1.5 billion people) are physically inactive. The authors (Hallal et al., 2012) noted that the frequency of inactivity varied across continents (e.g., 43.3% in the Americas, 34.8% in Europe), increased with age in all regions of the world, and was more common in countries of high income than in those of low income. In North America, less than 50% of people meet the recommendations for physical activity (Estabrooks, 2000; Ferrara et al., 2015). Among those people who do begin an exercise program, 50% are likely to dropout within 6 months (Estabrooks, 2000). Noteworthy, recent technological advancements, such as the use of smartphones to monitor daily physical activity, have the potential to change this gloomy reality.

To this extent, nearly two-thirds of Americans reported owning a smartphone (Pew Research Internet Project, 2015). A smartphone is defined as any cellular device that has additional functions including a camera, global positioning system (GPS), and Wi-Fi capabilities, and is running in one of the following mobile devices: iPhone, Android, BlackBerry, Windows Mobile and others (Bert et al., 2014; Ozdalga, Ozdalga and Ahuja, 2012). The smartphone industry has provided the impetus for the boom in the development of new mobile phone applications. Smartphone applications (i.e., apps) are computer programs designed to run on smartphones, and are available through application distribution platforms such as the Apple App Store, Google Play, or Windows Phone Store (Martin et al., 2015). Apps are downloaded from the platform to a mobile phone device and can be applied in various fields (e.g., social, educational, entertainment, and health and fitness), and are often free and easy to use (Bert et al., 2014).

Information technology researchers and companies devote attention to sports, fitness, and physical activities to support people with new apps for indoor and outdoor use (Buttussi and Chittaro, 2008). These apps may help to provide convenient and cost-effective opportunities for individuals to start and maintain a physical exercise program. To this extent, Middelweerd et al. (2014) examined apps that promote physical activity and reported that the iTunes and Google Play platforms stored approximately 23,000 and 18,000 smartphone apps categorized as Health and Fitness, respectively. Many of those apps were available for download at no cost, confirming the notion that the use of exercise apps may be an inexpensive means to promote and maintain physical activity (Ferrara et al., 2015). In fact, health educators have adopted new technologies such as wearables and smartphone apps as potential tools for exercise behavior change (Filho and Tenenbaum).

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The recent focus on smartphone apps is not surprising due to their potential to support individuals in the process of adopting and sustaining a new healthy behavior (Stawarz, Cox and Blandford, 2015; Middelweerd et al., 2015). A recent qualitative inquiry among college students revealed that most participants downloaded an app to meet a health goal and felt that the app helped them to meet their goal. Two distinct groups emerged in this study, those who used apps to adopt a new behavior, and those who used them to support an established behavior (Gowin et al., 2015). It follows that motivational readiness to begin or maintain physical activity is rooted within the trans-theoretical model (Prochaska et al., 1992), in which behavior change is conceptualized as a process that unfolds over time and involves progression through a series of five stages: precontemplation, contemplation, preparation, action, and maintenance. The model posits that individuals progress through the stages of change in a cyclical rather than linear fashion because many individuals do not succeed at establishing and maintaining lifestyle changes.

In the *precontemplation stage*, individuals have no intention to engage in physical activity in the foreseeable future and are typically unaware of their problems. In this stage, individuals may be demoralized about behavior change, defensive because of social pressures, or uneducated about the long-term benefits of physical activity and exercise. In the *contemplation stage*, individuals are aware that a problem exists and are seriously considering overcoming it, but have not yet made a commitment to take action. It is common for people to remain stuck in this stage and have momentary thoughts about starting to exercise but not act on those thoughts. The *preparation stage* combines intention and behavioral criteria. At this stage, people have taken action to make behavioral changes, such as exercising a little but not yet regularly. Individuals in the *action stage* exercise regularly (i.e., three or more times a week for 20+ min.) but have been doing so for less than 6 months. Due to the high level of commitment, time, and energy required, this is the least stable stage and, as such, it often carries the highest risk for relapse. In the *maintenance stage*, individuals have been exercising regularly for over 6 months and are likely to continue to participate in regular physical activity throughout the lifespan. In fact, people in this last stage have been found to be more intrinsically than extrinsically motivated (Buckworth et al., 2007). Finally, to prevent relapse and consolidate the gains attained during action, people develop accountability mechanisms that can include the use of technology (Pew Research Internet Project, 2015; Castellano and Casamichana, 2014).

In the present study, we were interested in exploring whether the use of smartphones would be related to individuals willingness to both maintain and initiate regular physical activity. More specifically, the purpose of this study was to explore the degree to which smartphone-based fitness applications help people start and maintain a regular physical activity across North America, South America and Europe. To this end, we grounded our study on the trans-theoretical model of behavior change, which purports that people go through different stages to initiate and sustain change, which in turn is influenced by access to material means, such as technological aids.

Method

Participants

A total of 904 participants responded to the survey via the use of social networks Facebook® and LinkedIn®. Participants were from three different continents and more than nineteen countries: North America (USA and Canada), South America (Brazil, Chile and Colombia), and Europe (Portugal, Spain, England, France, Italy, Belgium, Germany, Bulgaria, Ireland, Scotland, Greece, Turkey, Czech Republic and Denmark). The inclusion criterion to participate in the study required participants to own a smartphone.

The gender split was even across the three continents being sampled: North America (106 men – 52.48%, 96 women – 47.52%), South America (264 men – 52.50%, 237 women – 47.50%), and Europe (107 men – 52.48%, 95 women – 47.52%). Although a total of six age categories were sampled (under 20; 21-30; 31-40; 41-50; 51-60; above 61), the following age ranges comprised the vast majority of responses across the three continents: 21-30 in North America (108 participants – 53.47%) and South America (242 participants – 48.30%), in Europe the age range was 31-40 (n.91 – 45.27%). Of the total participants, 334 respondents (36.94%) reported never downloading any fitness applications on their smartphone while 570 (63.06%) reported downloading at least one fitness application on their smartphone.

Instruments

An informed consent section, presented immediately after the survey link was opened, informed participants of the purpose of the study, confidentiality terms, and explained what would be required of them to participate. The survey was composed of five demographic questions (age, gender, continent of residence, country of residence, and city of residence), eight closed questions (frequency, duration, intensity, and type of physical activity, reasons for engaging in physical activity, physical activity app ever downloaded onto smartphone, which physical activity app, which app features do you consider most beneficial in helping begin and maintain your physical activity), and two Likert-type response questions (belief that any of the Physical Activity apps help one begin and/or maintain a physical activity routine).

The survey was made available in three languages: English, Portuguese and Spanish. Initially, the survey was created in English. For translation to Portuguese and Spanish languages, the back-translation method was implemented, akin to previous cross-cultural studies in the area (Carvalho and Borges, 2012). Three academic experts that were well-experienced with adapting and validating measurement instruments were selected to assist with the translation of the survey into Portuguese and Spanish. For the first phase of the translation process, each expert read the original English version of the survey and translated the items individually into each of the languages (Portuguese and Spanish). The different versions were then pooled and compared among the three experts, resulting in a Portuguese and Spanish version of the original English survey. The second phase of the translation process incorporated the aforementioned back-translation procedure, which involves translating the obtained language version(s) (i.e., Portuguese and Spanish) back to the original language (English). For this part, three other multilingual experts, with knowledge and experiences similar to the first group, reversed the translation process by translating the Portuguese and Spanish version back into English. In the third and final phase, a new scientific committee, three different multilingual experts, with knowledge and experiences similar to the first and second group, compared the original English version of the survey with the English version established by the back-translation procedure. This committee verified that the items from these two versions had the same meaning, considering the nuances of the language and cultural aspects.

Procedure

The research was conducted according to the ethical research principles involving human subjects. Data collection commenced after obtaining approval from the Research Ethics Committee.

The electronic survey was administered through Google Drive®. This free online service provides storage and file synchronization, which offers online solutions such as creating and editing documents, spreadsheets, presentations and surveys for research. The primary means of data collection was through social networks: Facebook® and LinkedIn®. Through the use of these engines the authors posted a message for people to participate, and provided the link to the survey.

Results

Physical activity (PA) applications use

Prior to examining the PA index, we have calculated the applications' brands and the feature which are mostly used in the market. These results are presented in Table 1.

Of the total sample, 36.4% have not used any smart-phone PA application. Of the majority who used these applications, Runkeeper (14%), MyFitnessPal (12,2%), Runtastic (9.3%), and Nike+ (9.4%) were the mostly used. The most important features of the PA technology were "tracking calories burned" (34.7%), "tracking run distance and mapping" (19.7%), and "monitoring and recording heart rate" (18.5%).

Application	N	%	Features	N	%
None	329	36.4	None	202	22.4
Runkeeper	127	14.0	TTCB	313	34.7
MyFitnessPal	110	12.2	MRHR	167	18.5
Endomondo	44	4.9	TRDMR	178	19.7
Runtastic	84	9.3	PADSMC	26	2.9
Seven	16	1.8	Other	17	1.9
FitStarYoga	11	1.2			
FitnessPoint	12	1.3			
GoogleFit	16	1.8			
WalkLogger	2	0.2			
Nike+	85	9.4			
Other	68	7.5			

Note: TTCB = tracking total calories burned, MRHR = monitoring and recording of heart rate, TRDMR = tracking run distance and mapping the route, PADSMC = sharing details of physical activity on social media to boost confidence

Table 1. PA Applications used and features' preferences

PA Index as a function of smartphones' applications

The PA index was contrasted among several demographic categories followed by one-way analyses of variance (ANOVA) procedure.

Gender. The first contrast pertained to gender. Males acquired significantly, $F(1, 902) = 22.78$, $p < .001$, higher PA Index than females ($M = 47.36$, $SD = 22.88$ vs. $M = 40.38$, $SD = 20.46$, $d = 0.33$).

Continent. A similar analysis was performed for the continent from which participants use smart phone applications. A strong tendency for significance emerged, $F(2, 901) = 2.76$, $p < .06$. Specifically, participants from Europe ($M = 47.44$, $SD = 22.49$) reported a higher PA Index than those from both North America ($M = 42.72$, $SD = 21.54$, $d = 0.22$), and South America ($M = 43.65$, $SD = 22.11$, $d = 0.18$).

Reason for Exercising. People who practiced for "professional reasons" ($M = 66.09$, $SD = 37.13$) and "physical conditioning" ($M = 65.00$, $SD = 24.75$) had the highest PA Index followed by people who exercise for "activity enjoyment" and "body image" ($M = 51.79$, $SD = 19.87$, and $M = 49.72$, $SD = 20.57$, respectively). For those who exercise for reasons such as "weight loss", "health goals" and "improve quality of life" the PA Index ranged between 40.39 – 46.63. The "not regularly active" people had a mean PA Index of 13.05 ($SD = 18.59$). These differences resulted in a significant overall ANOVA, $F(7, 896) = 37.69$, $p < .001$, and an eta = .48.

PA Application. People who downloaded and used the PA application had a significantly, $F(1, 901) = 28.82$, $p < .001$, higher PA Index than those who refrained from it ($M = 47.26$, $SD = 20.99$ vs. $M = 39.21$, $SD = 23.05$; $d = 0.38$).

PA Index as a function of application-type. Figure 1 depicts the PA Index associated with the various smartphone applications as well as the ones who do not use these applications. People who use FitnessPoint ($M = 55.67$, $SD = 18.49$), MyFitnessPal ($M = 48.43$, $SD = 21.02$), and Runtastic ($M = 45.48$, $SD = 21.28$) had the highest PA index while those who practice FitStarYoga ($M = 30.18$, $SD = 13.27$), and WalkLogger ($M = 31.00$, $SD = 41.0$) had the lowest PA Index. These differences tended strongly toward significance, $F(11, 892) = 1.73$, $p < .06$.

PA index as a function of beginning and maintaining exercising. People who believe that applications helped them to begin exercising showed a higher PA index, $F(4, 899) = 3.\ 57$, $p < .007$, eta = .12. Specifically, people who rated the effects as "very little" had a mean PA index of $M = 41.99$, $SD = 22.87$, and this gradually increased to $M = 47.38$, $SD = 21.76$, $d = 0.26$ for people who rated it "very much" (see Figure 2). A similar significant trend, $F(5, 897) = 5.24$, eta = .17 was evident for "maintaining exercise". People rating this "very little" had a PA Index of $M = 42.40$, $SD = 23.57$, and this increased to $M = 50.73$, $SD = 24.91$, $d = 0.40$, for those who rated it "very much" (see Figure 2). It is worth noting, however, that most of the sampled participants maintained that the smart phone applications have very little to do with beginning (31.1%) or maintaining (32.6%) physical activity, little (22.8% and 21.2%, respectively), moderate (25.0% and 25.0%, respectively), much (14.9% and 13.7%, respectively), and very much (6.2% and 7.4%, respectively).

PA Index prediction

Two linear regressions were performed to estimate the overall accounted variance of three clusters of variables to the overall PA Index. The three clusters were: (a) demographics (e.g., gender, continent, smartphone PA application download), (b) PA reasons, and (c) the degree to which the application supported one's PA

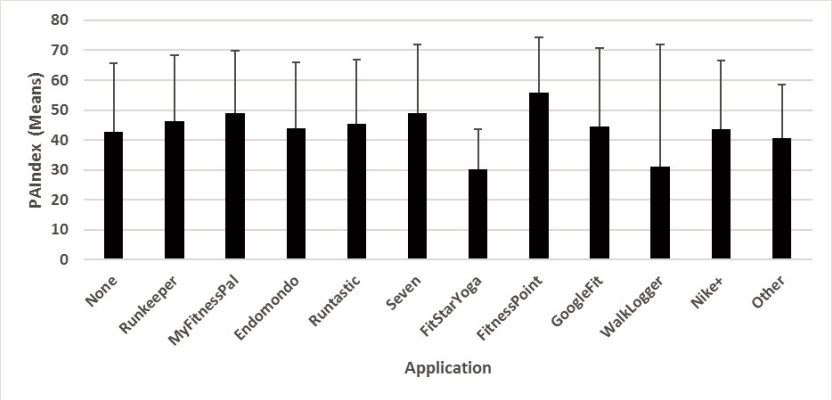

Figure 1. Means and SDs for PA Index by PA Application

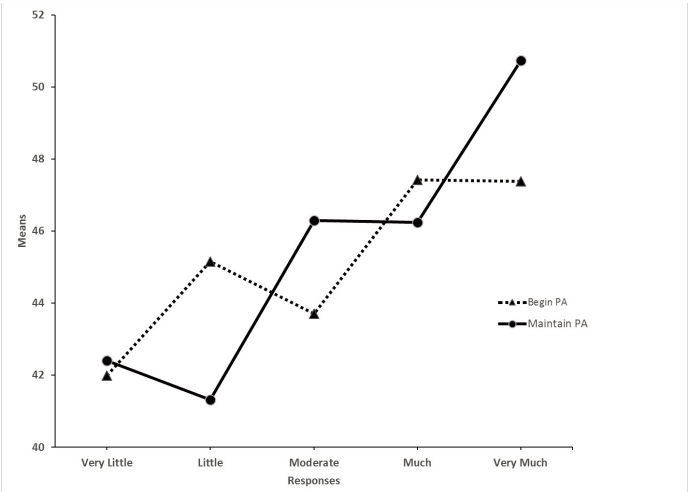

Figure 2. PA Index Influence on Initiating and Maintaining PA

initiation/maintenance. In the two regression procedures, the first two clusters were identical, and the third one was either beginning or maintenance of PA. The regressions are presented in Table 2 (note that since the first two clusters were identical, only the third cluster was added to the Table).

ANOVA results, gender, continent, and the decision to download a smartphone PA application were significant ($p < .001$) and together accounted for 5% of the PA Index variance. Specifically, people downloading a PA application, males, and Europeans were characterized as engaging more in PA. Moreover, the reasons for engaging in PA significantly ($p < .001$) predicted the PA Index, and added 7% to its accounted variance (e.g., "professional reasons" and "physical conditioning" were associated with higher PA Index). However, the beliefs that the PA application has a role in initiating or maintaining PA has not added any significant accounted variance to the PI index.

Discussion

Results from the online questionnaire revealed that apps for running were the most popular across the sample, which included over 900 people from three continents and 19 different countries. Indeed, large-scale epidemiologic research suggests that people tend to engage more in aerobic exercise, such as running, than other forms of PA, such as strength and flexibility training (Pollock et al., 1998). Individuals, particularly the elderly, need to be educated about the importance of engaging in various types of PA beyond aerobic exercise that have been found to prevent falls (Nelson et al, 1994). Given that PA engagement depends on myriad factors (e.g., age; socioeconomic status; public policies), additional research on the personal and social affordances of anaerobic strength and flexibility is warranted.

Our results also revealed that people who have downloaded PA apps to their mobile phones have higher PA indexes than those who reported not having downloaded any app. To this extent, Filho and Tenenbaum (2018) have noted that engagement with exercise technologies is likely dependent on motivation to exercise. This is in agreement with the trans-theoretical model of exercise, as people in the action stage are likely committed to finding strategies to support their PA behavior. In other words, people that are "into exercising" are more prone to follow technological trends in the PA domain. In fact, previous research supports the notion that "early adopters" of technological software and hardware within a given domain tend to be those individuals interested (i.e., "personally attracted") in that domain in the first place (Agarwal et al., 1998; Lu, Yao and Yu, 2005).

Variables			ANOVA					
	B	*P*	*F*	*Df*	*P*	*R*	R^2	ΔR^2
Model 1								
Download	0.15	0.001	15.85		3,90.001	0.22	0.05	0.05
Gender	-0.11							
Continent	-0.008							
Model 2								
PA Reasons	0.27	0.000	30.58		4,8990.001	0.35	0.12	0.07
Model 3								
PA Initiation	0.04	0.24	24.75	5, 898	0.001	0.35	0.12	0.00
PA Maintenance	0.55	0.09	25.09	5, 898	0.001	0.35	0.12	0.00

Note: Download = yes/no, Gender = male/female, Continent = North America/South America/Europe, PA Reasons = Not regularly physically active/Enhance Body Image/Weight Loss/Health Goals/Improve Quality of Life/Enjoyment of the activity/Physical Conditioning/Other, PA Initiation and Maintenance = Very Little/Little/Moderate/Much/Very Much.

Table 2. Regression PA Index as a DV and demographics, reasons for engaging in PA, and PA initiation/maintenance as 3-cluster predictors.

Furthermore, our analyses revealed that males downloaded significantly more apps than females. We conjecture that women download fewer PA apps because they tend to be less physically active than males (Troiano et al., 2008). Although an increase in women's participation in PA has been observed over the years, there remains a gap between the amount of PA activity practiced by males and females (Hallal et al., 2012). This gap has been partially attributed to the different treatments that boys and girls receive from their parents and society at large (Telford et al., 2016). Stereotypically, sport and exercise has been portrayed as a "boys' thing" rather than a "girls' thing" (Cairney et al., 2012). Although this stereotypical view has been challenged in certain cultural milieus, some secular societies remain less accepting of women's engagement with sports (Kahan, 2003). Thus, we echo the notion that encouraging girls to practice in PA early in life is paramount to motivate consistent healthy PA habits in adulthood (Cairney et al., 2012; Telford et al., 2016).

Our results also suggest that participants' continent of origin may influence one's PA index. Specifically, our analysis revealed that individuals from different continents showed different PA indexes, albeit these differences were only marginally significant. Public policies, preferred modes of transportation (e.g., public or private), dietary habits and working hours might all explain why residents of some countries are more active than people from other nations (Hallal et al., 2012). As such, more cross-cultural research is needed to unravel the bio-psycho-social mechanisms that might explain why members of some societies are less active than members of other societies.

The PA index was higher for people who reported downloading apps to track more dynamic "whole-body activities" (e.g., running), compared to those who reported downloading relatively less dynamic PA (e.g., yoga). It is likely that one's PA index will partially depend on autonomy, competence and socializing factors akin to the tenets of self-determination theory (Deci and Ryan, 2011; Luckwu and Guzmán, 2011). As well, the theory of planned behavior might also help to explain whether ones' intention to start an exercise regime might depend somewhat on his/her attitudes towards PA accessory tools, including PA apps. While our research did not yield insight on why people start and continue to exercise, our findings did suggest that downloading apps is not a reliable predictor of people's desire to initiate and maintain PA behavior (see Figure 2). Rather, the opposite might be true: only motivated individuals will choose to download PA apps. A qualitative inquiry might be fruitful in revealing why people choose to download PA apps.

Limitations, Future Research and Implications

This study is not without limitations. First, this study is a cross-sectional cut of the linkage between PA behavior and the use of exercise apps. A long-range longitudinal study is warranted to address how motivation to exercise influences technological software searching, and how it changes over time. Mixed-method design studies could help to clarify whether motivation leads to more apps downloaded, or whether the emergence of new technologies is motivating people to exercise. Second, this study was based on a convenience sample, and thus a representative snapshot of the entire population cannot be inferred. In other words, the findings of the current study only apply to young adults and cannot be extrapolated to other age cohorts. Despite these limitations, this paper advances research in exercise psychology, particularly on how the use of software technology relates to motivation from both an applied and theoretical standpoint.

From an applied standpoint, the download of exercise apps might be linked to demographic and social factors or "barriers", namely gender and continent of origin. Moreover, we found that apps to track aerobic activity were more likely to be downloaded than those related to anaerobic power, strength and flexibility, probably because people engage more in aerobic activity in the first place.

From a theoretical standpoint, our findings suggest that a stage theory informs only part of the linkage between PA index and motivation. Put differently, our findings do not allow for a conclusion on whether the download of exercise apps is linked to either the initiation or the maintenance of PA. In fact, our findings only suggest that people with a higher PA index are early adopters of exercise apps, likely because they are interested in exercise in the first place and thus are more likely to be attuned to technological content on PA. To advance knowledge on whether and how the consumption of exercise technology is linked to the initiation and maintenance of PA it is important to conduct longitudinal studies informed by multi-theoretical frameworks, akin to the notion of *explanatory pluralism.* The links between technology use and exercise initiation and adherence are multilayered and complex and require different theoretical outlooks and methodological instances. Accordingly,

a multi-theoretical framework combining the tenets of the trans-theoretical model, self-determination theory, and the theory of planned behavior might better explain the linkage between PA behavior and exercise related technology usage.

APLICACIONES DE TELÉFONOS INTELIGENTES UTILIZADAS PARA INICIAR Y MANTENER LA ACTIVIDAD FÍSICA: UN ANÁLISIS EXPLORATORIO

PALABRAS CLAVES: *smartphones*; aplicaciones; actividad física; motvación.

RESUMEN: El objetivo de este estudio fue explorar el grado en el que las aplicaciones de *smartphones* ayudan a las personas a iniciar y mantener una actividad física regular. Este estudio descriptivo y exploratorio consistió en 904 encuestados de tres Continents. Una encuesta compuesta de preguntas demográficas, preguntas cerradas y escalas con respuestas de tipo Likert fue desarrollada y distribuida a través de medios sociales. Los resultados revelaron que 52,3% de los participantes en América del Sur, 72,7% en Norteamérica y 80,1% en Europa habían descargado una aplicación de actividad física en sus *smartphones*. De ellos, 8,1% en América del Sur, 5,9% en Norteamérica y 1,9% en Europa informaron que la aplicación les ayudó mucho a comenzar un régimen de ejercicios. Del mismo modo, 8,9% de América del Norte, 6,9% de Europa y 7,1% de América del Sur informaron que les ayudó mucho a mantener su régimen de ejercicios ya implementado. Los hallazgos revelaron que las aplicaciones de fitness para *smartphones* tienen un efecto limitado en el compromiso con el ejercicio; Para la mayoría que los descargan, las aplicaciones permanecen sin usar, y en esta etapa no se convirtió en parte de su estado mental interno.

O USO DE APLICATIVOS DE SMARTPHONES NO INÍCIO E MANUTENÇÃO DA ATIVIDADE FÍSICA: UM ESTUDO EXPLORATÓRIO

PALAVRAS-CHAVE: *smartphones*; aplicativos; atividade física, motivação.

RESUMO: O objetivo do estudo foi verificar se os aplicativos fitness de *smartphones* ajudam as pessoas no início e manutenção de uma atividade física. Este estudo descritivo e exploratório consistiu em 904 entrevistados de três continentes, América do Norte, América do Sul e Europa. Uma pesquisa composta de questões demográficas, perguntas fechadas e escalas com respostas de tipo Likert foi desenvolvida e distribuída através de mídias sociais. Os resultados revelaram que 52,3% dos participantes na América do Sul, 72,7% na América do Norte e 80,1% na Europa já tinham baixado um aplicativo de atividade física em seus *smartphones*. Desses, 8,1% na América do Sul, 5,9% na América do Norte e 1,9% na Europa relataram que o aplicativo os ajudou muito no início de um regime de exercícios. Da mesma forma, 8,9% da América do Norte, 6,9% da Europa e 7,1% da América do Sul informaram que o aplicativo os ajudou muito a manter seu regime de exercícios. Os resultados revelaram que os aplicativos de fitness para *smartphones* têm efeito limitado no engajamento de exercícios; Para a maioria que os descarta, os aplicativos ainda não foram utilizados, e nesta fase não se tornou parte de seu estado mental interno.

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