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Exploring Factors Affecting Active Video Gaming and General Physical Activity

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요 약

신체 활동 증진을 위한 디지털 게임의 높은 활용에도 불구하고, 활동형 게임 이용에 영향을 미치는 요인에 대한 체계적 이해는 부족하다. 이 연구는 건강 행위의 생태학적 모형을 기반으로, 신체 활동에 영향을 미치는 요인을 개인적, 환경적, 사회적 요인으로 세분화하고, 신체 활동을 활동형 게임 이용과 일상적 신체 활동으로 구분하여 각 행위에 영향을 미치는 요인을 통합적으로 살펴보았다. 그 결과, 일상적 신체 활동은 세 요인이 모두 영향을 미치는 것과는 달리 활동형 게임 이용에는 사회적 요인만 영향을 미치는 것으로 나타났다. 이는 활동형 게임 이용 확대에 사회적 요인이 중요한 영향을 미칠 수 있음을 시사하고 있다.

ABSTRACT

Despite the widespread use of digital games as a means of promoting physical activity, little is known about the factors that affect active video gaming. Based on the ecological model of health behavior, this study examined how personal, environmental, and social factors would influence active video gaming and general physical activity. The results showed that while all three factors significantly influence general physical activity, social factor is the only factor that affects active video gaming. The finding highlights the importance of social factors in predicting the use of active video games.

Keywords : Active Video Gaming(AVG), Ecological Model of Health Behavior, Physical Activity(PA), Adolescence

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1. Introduction

Although regular physical activity (PA) is a well-known contributor to lifelong health, today's young people are less likely to engage in PA. According to a recent report from Kann et al.[1], only twenty-six percent of high school students meet the national PA guideline for young people aged 6 to 17 years (i.e. at least 60 minutes of PA per day on all 7 days). Lack of PA in childhood and adolescence is appeared to be a critical risk factor for chronic diseases (e.g., obesity, coronary heart disease, high blood pressure, stroke, type 2 diabetes, osteoporosis, and colon cancer) and even premature deaths in adulthood[2]. Despite increases in the public awareness about the risk, unfortunately a sharp decrease in PA takes place during adolescence[2,3]. Thus, it may be argued that interventions to promote PA in adolescence should largely prevent the development of detrimental diseases, eventually leading to enhance public health in general.

As playing video games has been growing in popularity as a culture of the digital age, the idea of using video games to motivate adolescents to be more active emerged. Active video games (AVGs) are a genre of video games that require upper, lower, or full body movements, thereby having the potential to increase PA[4]. In fact, a large number of AVG studies have reported that AVG play increases energy expenditure, heart rate, and other PA indicators[5,6,7]. Thus, this study may argue that AVGs are expected to increase adolescents' PA as a substitute of traditional exercise equipment. Nonetheless, relatively few studies have investigated the potential predictors of AVG play, while growing body of PA studies have identified the reinforcing values of PA in adolescence. In keeping with the findings of previous PA studies, this study aims to explore how personal, environmental, and social factors would influence AVG play in adolescence, which in turn helps develop effective game-based health interventions to promote PA behavior in adolescence.

2. Literature Review

2.1 Ecological Models: Correlates of Physical Activity in Multiple Levels

A useful theoretical framework for explaining why and how adolescents engage in PA is the ecological model of health behavior[3]. The model postulates that health behavior is influenced by multi-level factors, including intrapersonal, interpersonal, organizational, community, and policy influences. Drawing upon the core principle of ecological perspective, PA researchers have investigated the effects of personal, environmental, social factors on PA behavior, identifying the potential correlates of PA in adolescence[8,9].

Personal factors in the PA research refer to individuals' attitudes and beliefs related to PA behavior, such as affective orientation towards PA, and beliefs about health outcomes in PA. In fact, various personal factors (e.g., enjoyment in PA) have been discussed in existing PA studies, and it is generally

assumed that positive attitudes toward PA and strong beliefs about health outcomes make PA fun and engaging[10,11]. Of the personal factors examined in the previous PA studies, personal factors of AVG play have been operationally defined as enjoyment in PA, perceived energy increases, feeling good, and feeling of success in the present study.

Enjoyment in PA has been shown to increase PA participation and engagement[12]. Sallis and Owen[13] and Salmon, Owen, Crawford, Bauman, and Sallis[14] reviewed PA literature and found enjoyment in PA to be positively related to PA behavior, with higher levels of enjoyment in PA being associated with higher levels of PA. Similar findings were also found in other PA studies[8,15]. Since AVG play can be a form of PA, this study hypothesized that personal factors would positively influence general physical activity as well as active video gaming:

H1a: Personal factors will be positively associated with active video gaming.

H1b: Personal factors will be positively associated with general physical activity.

Barriers to PA have been discussed as a strong influence, and as its external barriers, environmental factors emerged as significant determinants of PA. Environmental factors refer to the underlying conditions in which individuals are situated, including familial and societal structure[16]. Although environmental factors and those influences on PA have been reported in multiple studies, factors mainly discussed in existing PA studies are accessibility and/or availability of exercising equipment (e.g., balls, bicycles, skates) and recreational facilities (e.g., playgrounds, parks), and neighborhood safety[8,17].

Using exercise equipment and access to facilities have been reported to increase PA among adolescents[18]. Living in safe neighborhoods is also associated with greater PA behaviors[19]. A report from the Centers for Disease Control and Prevention[20] found perceived neighborhood safety to be positively associated with PA. In contrast to the findings of previous PA studies, adolescents may be encouraged to enjoy active video gaming when they have no available exercise facilities or unsafe neighborhoods. Thus, it may be argued that environmental factors could be negatively associated with active video gaming, in contrast to general physical activity.

H2a: Environmental factors will be negatively associated with active video gaming.

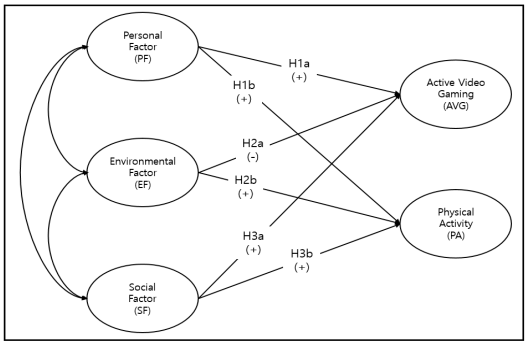
H2b: Environmental factors will be positively associated with general physical activity.

A number of PA studies have indicated social support as an important social factor of PA and reported a consistent positive association[21,22]. In their studies of adolescents, social factors generally refer to one's perception of how significant others help themselves participate in PA, including PA encouragement of adults in household, PA participation of adults in household, and so on[23]. Sallis et al.[9] reviewed studies and found support and direct help from family were consistently associated with regular PA. Aaron, Storti, Robertson, Kriska, and LaPorte[24] and Ogden et al.[25] have also reported that parent participation and encouragement in PA appear to be positively influences on adolescents' PA levels. Thus, this study hypothesized that social factors

would help adolescents more physically active and the adolescents may be also encouraged to use AVGs at home as a form of PA interventions.

H3a: Social factors will be positively associated with active video gaming.

H3b: Social factors will be positively associated with general physical activity.



[Fig. 1] Proposed research model

3. Materials and Methods

3.1 Data Source and Sampling Procedure

While multiple national datasets have been used to examine PA behavior in adolescence such as Youth Risk Behavior Surveillance System (YRBSS), few data sources include adolescents' use of AVGs as a means of being physically active. The data for this study came from National Youth Physical Activity and Nutrition Survey (NYPANS), conducted by the Centers for Disease Control and Prevention (CDC). In the NYPANS, data were collected and analyzed to evaluate physical activity and dietary behavior in school-aged youth and to identify determinants of their behavior, using a paper-and-pencil questionnaire. The NYPANS employed a three-stage cluster sample design to obtain a nationally representative sample of US high school students in grades 9 through 12, including public, Catholic, and private high school students in the 50 States and the District of Columbia. With the sampling frame, 12,907 students were selected as subjects, but 11,458 students (88% of the sampled students) responded to the request. After careful review of each questionnaire and also detecting and removing outliers, 10,654 questionnaires were used in the data analysis. The cut-off values for detecting outliers were z-score of +3 and -3.

In terms of the descriptive characteristics of the analytical sample, a majority (74%) of the respondents were from 14 to 17 years of age. Slightly less than half (49.7%) of the entire sample were females. Similar proportions reported 9^{th} grade (24.8%), 10^{th} grade (24.9%), 11^{th} grade (24.2%), and 12^{th} grade (24.9%). Almost seventy percent (68.5%) were non-Hispanic/Latino. More specifically, more than half of the respondents were White (49.4%) or African American (27%), and only 2.4 percent were Asian.

3.2 Measures

Personal Factor. Five Likert-type scaled items were used to measure personal factor on a scale of 1 to 5, with "1" being "strongly disagree" and "5" being "strongly agree" (M = 4.21, SD = .67, α = .84). All respondents were asked if they would agree or disagree with the following statements: (1) When I am physically active, I enjoy it; (2) When I am physically active, I find it fun; (3) When I am physically active, it gives me energy; (4)

When I am physically active, my body feels good; and (5) When I am physically active, it gives me a strong feeling of success.

Environmental Factor. Three items rated on a 5-point scale ranging from 1 (strongly disagree) to 5 (strongly agree) were used to measure environmental factor (M = 3.84, SD = .88, α = .53). All respondents were asked if they would agree or disagree with the following statements: (1) At home there are enough pieces of sport equipment (such as balls, bicycles, skates) to use for physical activity; (2) There are playgrounds, parks, or gyms close to my home that are easy for me to get to; and (3) It is safe to be physically active by myself in my neighborhood.

Social Factor. Four items with 5-point scale on a scale of 1 to 5, with "1" being "Never," "2" being "1-2 times/week," "3" being "3-4 times/week," "4" being "5-6 times/week," and "5" being "Daily" were used to measure social factor (M = 2.45, SD = 1.11, α = .79). All respondents were asked to respond the following questions about the adults they live with. For example, during a typical week, how often an adult in their household would (1) encourage them to do physical activities or play sports; (2) do a physical activity or play sports with them; (3) provide transportation to a place where they can do physical activities or play sports; and (4) watch them participate in physical activities or sports.

Active Video Gaming. To measure active video gaming, all respondents were asked to report how many days in the past 7 days (ranged 0 to 7 days) they played active video games such as Wii, Dance Dance Revolution (DDR) (M = .87, SD = 1.31).

Physical Activity. All respondents were asked to indicate how many days (ranged 0 to 7 days) they were physically active for a total of at least 60 minutes per day in the past 7 days (M = 4.13, SD = 1.86).

4. Results

To test our research model, structural equation modeling (SEM) was performed. SEM is a multivariate analytical technique to simultaneously test hypothesized relationships between variables[26]. In this study, the model postulated the effects of personal, environmental, and social factors on AVG play and general PA (see Fig. 1). The correlations between key variables are shown in Table 1. A large number of missing values were found in the dataset and some variables were not normally distributed to some extent. Thus, missing values were replaced with mean of each variable to get goodness of fit and modification indices in SEM.

[Table 1] Bivariate correlations between key constructs (N = 10,654)

Variable	1	2	3	4	5
1. Active Video Gaming	–				
2. Physical Activity	.04**	–			
3. Personal Factor	.01	.30**	–		
4. Environmental Factor	.03**	.24**	.30**	–	
5. Social Factor	.07**	.34**	.28**	.30**	–

Note: **p < .01, two-tailed.

4.1 Evaluation of the Research Model

For the measurement model, construct validity was assessed using standardized factor

loadings. All of the item loadings ranged from .44 to .84, above the recommended .40 minimum guideline[27]. In addition, Cronbach's alpha was used to assess construct reliability. In this study, alphas for the scales generally exceeded the commonly accepted level (.70), but an exception was found in the environmental factor (α = .53) scale. Since alphas from .50 to .70 indicate moderate internal reliability and thus all the scales were used for further analyses[28]. Both factor loadings and alphas were shown in Table 2.

[Table 2] Measurement model

Construct	Indicators	Std. Loading	α
Personal Factor (PF)	PF1	.84	.84
	PF2	.79	
	PF3	.64	
	PF4	.67	
	PF5	.62	
Environmental Factor (EF)	EF1	.63	.53
	EF2	.44	
	EF3	.51	
Social Factor (SF)	SF1	.68	.79
	SF2	.66	
	SF3	.75	
	SF4	.75	

The overall model fit was assessed using maximum likelihood in AMOS. A set of four fit indices was used to estimate its goodness of fit, including goodness of fit index (*GFI*), adjusted goodness of fit index (*AGFI*), comparative fit index (*CFI*), and root mean square error of approximation (*RMSEA*)[29]. Two commonly used fit indices [i.e., chi-square (x^2) and relative chi-square (x^2/df) statistics] were not included in this study because the measures are highly dependent on sample size[30].

The values for the structural model indicated an adequate fit: *GFI* = .951, *AGFI* = .926, *CFI* = .919, *RMSEA* = .067. Modification indices suggested correlated measurement errors in the personal factor measure would improve overall model fit; covariance between item 2 and 3 (*MI* = 1295.28, *estimated parameter change* [*EPC*] = .20), covariance between item 4 and 5 (*MI* = 901.41, *EPC* = .08), and covariance between item 1 and 2 (MI = 545.59, EPC = .12). Goodness of fit has improved with each modification and therefore the modifications yielded a good fit: *GFI* = .990, *AGFI* = .985, *CFI* = .984, *RMSEA* = .030.

4.2 Hypotheses Testing

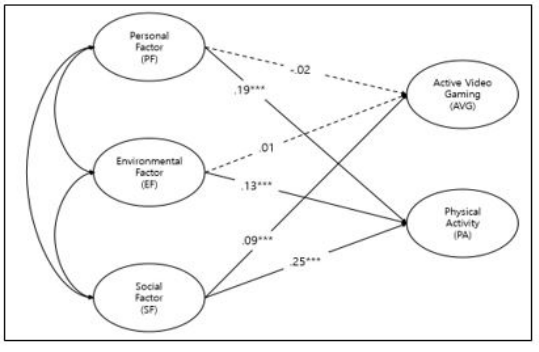
The modified research model and its significant structural paths and standardized coefficients are shown in Fig. 2. Two non-significant paths were included in this model. More specifically, personal factors [PF] did not significantly predict active video gaming [AVG] and environmental factors [EF] did not predict AVG. However, other individual paths in this model were significant.

Hypotheses 1a and 1b suggested that PF would positively influence both AVG and general PA. As explained above, the path from PF to AVG was not significant. Nonetheless, the path from PF to general PA was significant, suggesting that personal factors had a significantly positive effect on general physical activity. Hence, Hypothesis 1b was supported by the data.

Hypothesis 2a, which predicted a negative influence of EF on AVG, was not supported. As expected in Hypothesis 2b, however, the path from EF to general PA was significant.

Thus, environmental factors had a significantly positive influence on general physical activity. Hence, the data also supported Hypothesis 2b.

Hypotheses 3a and 3b predicted that SF would have a positive impact on AVG and general PA, respectively. As Hypothesis 3a predicted, the path from SF to AVG was significant. Hypothesis 3b, which predicted a positive influence of SF on general PA, was also significant. Thus, Hypotheses 3a and 3b were supported, suggesting that social factors led to both active video gaming and general physical activity.



[Fig. 2] Structural equation model with standardized coefficients

5. Discussion

Despite the growing popularity of digital games as a new means of promoting PA, a limited number of studies have identified important predictors of active video gaming while a number of factors have emerged as significant correlates of PA. Using variables examined in the previous PA research, this study was expected to identify the factors associated with AVG play in adolescence. Based on the ecological model of health behavior, personal, environmental, and social factors were used as three main constructs in this study, and thus this study proposed and examined a structural model testing the effects of personal, environmental, social factors on AVG play and general PA.

It is noteworthy that there is a difference between factors affecting AVG and general PA. Although all the paths from personal, environmental, and social factors to general PA were significant, only social factor had a significantly positive impact on AVG play. Considering the fact that AVG play is a form of PA, this result is consistent with extant PA studies that show the relationships between social support (e.g., encouragement) from parents, peers, or significant others and PA in adolescence[31,32]. However, the current results are not consistent with the ecological model of health behavior, which predicts the influence of multi-level factors (i.e., personal, environmental, and social factors) on PA.

More specifically, level of PA in adolescents can be enhanced when they have: positive attitudes toward PA and strong beliefs about health outcome; easy-to-access exercising equipment and facilities and safe neighborhood environment; parental support and direct help from parents. Although AVG play has been expected to be an useful indoor PA resource, in particular when adolescents have no available exercise facilities or unsafe neighborhoods, the findings of this study suggest that personal and environmental factors have no effects on the use of AVGs. This indicates that social factor is a key factor to use in-home game-based PA intervention,

which may help adolescents more active.

Taken together, AVGs have the potential to be used as an effective exercise tool to increase energy expenditure and PA level in adolescents because games are inherently fun. However, the results of this study highlights that these games need to be designed in strengthening social support from family adults (e.g., parental involvement) in order to increase the use of AVGs.

5.1 Limitations

Limitations in this study should be considered in the following studies. Although one of the notable strengths in this study is using the NYPANS data with a large national sample, this study also has some challenges inherent in the secondary data. More specifically, since the NYPANS was not designed to discuss AVG play as a focal issue, the information obtained from the dataset was not able to fully explain AVG play in general and answer the question of what game they usually play and whether they have any gaming console for AVG play.

In addition, even though the NYPANS is the only dataset that investigated the use of AVGs with a national sample of US high school student, the data were collected about a decade ago. The NYPANS showed that a limited number of US high school students had enjoyed AVG play. More specifically, more than half of the entire sample (58%) had never played AVGs, and only about 6% (5.7%) had played AVGs four days or more each week. However, the trend of using AVGs could have been changed during the last several years. Therefore, the results of this study need to be updated with the follow-up data collection.

Furthermore, the survey may not be fully satisfactory for this study. For example, Cronbach's alpha for the environmental factor was .53, but items were not able to be added to make those scales more reliable. The reliability might provide an explanation of why environmental factor had no influence on active video gaming. Therefore, it is necessary that additional items need to be placed to address the environmental influences on active video gaming, and the social influences of friends and significant others on active video gaming also need to be addressed to generalize the findings of this study.

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