Intermediary Effects for Adults’ Physical Activity: Comparison of two Structural Models

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ABSTRACT

Studies have indicated that past physical activity (PA) participation, exercise self-efficacy (ESE), friend support for PA and environmental factors enhance PA. No study has investigated the aforementioned factors within the context of the same theoretical model so far. The current study examined the relationship between past and current PA through both a social cognitive and an ecological model considering the intermediary effects of ESE, friend support for PA and neighbourhood environment. The sample consisted of 684 physically active men and women, aged 18-65 years old ($M \pm SD = 39.16 \pm 13.52$ years). Past and current PA, ESE, friend support for PA and neighbourhood environment were assessed. The examined models were analyzed using structural equation modeling. The models proved to be of appropriate fit. In both models past PA had a high positive effect on current PA. Within the social cognitive model past PA positively affected current PA through the effects of ESE and friend support. Regarding the ecological model, past PA positively influenced PA through the effects of neighbourhood environment, ESE and friend support for PA. Future studies should be carried out applying longitudinal data for a better understanding of these associations over time.

Key Words: Past exercise; Self-efficacy; Friend support; Neighbourhood environment; Causal associations; Mediators
INTRODUCTION

Regular physical activity (PA) has been proven to be an effective strategy for the prevention and treatment of obesity, metabolic syndrome, cardiovascular diseases, as well as for the reduction of depression and mortality rates (1-3). Despite the apparent benefits of PA, two thirds of adult populations of the European countries do not meet sufficient PA levels for enhancing health (4). These findings have led to an increased scientific interest in investigating factors that predict adults’ participation in PA (5,6).

Recent studies have indicated that participation in past PA (6,7) and exercise self-efficacy (ESE) (7,8) were important positive predictors of PA. Specifically, participation in PA at the ages of 10-19 and 40-64 years old has predicted the maintenance of a high level of PA in old age (6). In line with this, adults with past PA experience in school have maintained high PA levels (7). With regard to ESE that is an important concept of the Social Cognitive theory, has been proven that one’s belief in his/her ability to persist in exercising had a crucial role in the promotion of PA participation (7,8). In particular, it has been found that ESE had the highest positive effect on PA than various other psychosocial and environmental variables (8). Further, other studies, adopting an ecological framework in the PA investigation, have demonstrated that friend support for PA (7) and environmental factors, such as access to sidewalks and sport facilities (8,9), were positively associated with PA. Regarding the ecological approach, PA behaviour is influenced by a complex interaction among psychosocial and environmental factors (10).

However, the aforementioned concepts have not been examined within the context of the same theoretical model. In line with this, past PA, Social Cognitive theory and ecological approach have not been used in an investigation explaining the PA participation. So far, neither a social cognitive nor an ecological model accounting the PA levels, including the effects of past PA, ESE, friend support and neighbourhood environment, have been examined in the literature. The examination of the above factors within the context of the same theoretical model, using structural equation modeling (SEM), may lead to a better prediction and explanation of the PA participation compare to other studies that assessed either these factors in isolation or without applying SEM. Therefore, the purpose of the current study is twofold. First, it aims to examine a social cognitive model of the association between past and current PA through the intermediary effects of ESE and friend support for PA. The second purpose is to evaluate an ecological model of past PA, neighbourhood environment and PA. Specifically, the proposed social cognitive model was widened including neighbourhood environment. In the ecological model, the mediating effects of neighbourhood environment, ESE and
friend support for PA were assessed. An original aspect of this study was the investigation of the model with the best fit of the collected data.

**MATERIALS AND METHODS**

**Participants’ recruitment and sample size calculation**

The sample’s selection met the following criterion: 18-65 years old to exclude older adults and adolescents. In particular, the sample that was not randomly selected consisted of 752 participants who agreed to fill in the questionnaires. They participated in various exercise programs in the Sport Facilities of the Municipality of Athens, Greece. Due to listwise deletion both of missing values and outliers, 684 participants consisting of 206 men (30.12%) and 478 women (69.88%) aged 39.16 ± 13.52 years old (M ± SD) were used for the analyses.

The criterion of 10 participants per item (10:1 ratio) was utilized for the sample size calculation (11). In addition, an especial statistical algorithm for structural equation modeling was used (www.danielsoper.com) (12). In particular, a power of 0.8, an effect size of 0.1 and a significant level of 0.5 were the criteria for the sample size calculation (12).

**Assessments**

**Socio-demographic variables**

Age, gender, educational level, civil status, type of job and family income were recorded. Participants were asked to indicate their educational status with response options: elementary school, secondary school, pre-university studies, professional school, bachelor studies, master / PhD studies. These responses reflected the Greek educational system. In terms of civil status, participants were grouped into four categories: single, married, divorced, widowed. In addition, participants were asked to indicate their profession with response options including unemployed, workless (household etc.), job in private sector, job in public sector, independent job and retired. Finally, based on monthly self-reported income, participants were stratified into the following groups according to the Greek economical situation: < 1000 €, 1000 - 2000 €, 2000 - 4000 €, > 4000 € (per month).

**PA**

The International Physical Activity Questionnaire (IPAQ) short form was used for the PA assessment (13). The IPAQ-short form had seven days recall period,
consisted of six items measuring exercise frequency and duration and one item estimating sedentary behaviour. The six items evaluated the walking PA, moderate PA, vigorous PA and total PA indexes. The PA indexes were expressed in MET-minutes per week and were calculated as duration x frequency per week x MET intensity. The total PA index was calculated by adding the walking PA, moderate and vigorous PA indexes (13). Research data demonstrated satisfactory validity and reliability properties for the Greek version of the IPAQ (14,15).

Past PA

Past PA was evaluated using the following items: “Did you participate in PA in the past?”, “How many years did you participate in past PA?”. Particularly, the years’ number of participation in past PA was recorded as past PA.

ESE

ESE was assessed with a 5-item Self-Efficacy Scale (16) that estimated one’s belief in his/her ability to persist in exercising under the following situations: tired, bad mood, not having time, on vacation and raining or snowing. Research findings proposed adequate validity, internal consistency ($\alpha = 0.76$) and test-retest reliability ($r = 0.90$) for this scale (16). A recent study verified the sufficient factorial validity, internal consistency ($\alpha = 0.83-0.87$) and test-retest reliability ($ICC = 0.96$) of the scale’s Greek version (17).

Friend support for PA

Friend support for PA was evaluated with the Friend Support for Exercise Behavior Scale (FrSEBS) (18). This scale consisted of five items, such as my friends “exercised with me”, “offered to exercise with me”, “gave me helpful reminders to exercise”, “gave me encouragement to stick with my exercise program”, and “changed their schedule so we could exercise together”. The FrSEBS construct validity, internal consistency ($\alpha = 0.84$) and test-retest reliability ($r = 0.79$) are well established (18). In line with this, a study (19) suggested that the Greek version of the FrSEBS is valid and reliable ($\alpha = 0.86-0.91$, $ICC = 0.90$).

Neighbourhood environment

The neighbourhood environment was assessed with a valid scale (8) consisting of the following five items: “I possess home fitness equipment”, “My neighbourhood provides facilities (e.g., walking trail, park, fitness club) for PA”, “My neighbourhood provides a safe and well-maintained environment (e.g., adequate lighting and sidewalks) for PA”, “I have access to enjoyable scenery when engaging in PA”, and “I frequently observe other people exercising”. Recently, research
findings indicated satisfactory validity and reliability ($\alpha = 0.84-0.86$, $ICC = 0.87$) for the Greek version of this scale (20).

**Ethical approval, study design and data collection**

The National and Kapodistrian University of Athens’ ethical committee approved this cross-sectional study that was carried out from February to May in 2012. A research group informed individuals exercising in the sport facilities about the study. The volunteers who were interested in taking part in the study signed the consent form and filled in the questionnaires.

**Statistical Analyses**

Means, medians, standard deviations, frequencies, sums, skew, kurtosis and normality tests were performed. A preliminary examination of the associations among the socio-demographic variables and the total PA index was conducted using the Spearman $r$ coefficient. The variables that were significantly associated with the PA index were used as covariates in the examined models. In particular, the analyses among the socio-demographics variables and PA indicated significant associations between: (a) age and PA ($r = -0.27$, $p < 0.01$) and (b) gender and PA ($r = -0.22$, $p < 0.01$). Therefore, age and gender were used as covariates in the examined models. The SPSS 17.0 statistical software (SPSS Inc., Chicago, IL, USA) was used for the analyses.

**Model testing**

The structural models were analyzed following two steps: (a) confirmatory factor analysis (CFA) for assessing the fit of the measurement models, and (b) SEM for testing the fit of the structural models (11,21). Analyses were conducted with the AMOS 16.0 statistical software (Amos Development Corporation, Chicago, IL, USA).

**CFA**

Separate CFA utilizing maximum likelihood estimation were conducted to assess the measurement models of the Exercise Self-Efficacy Scale, FrSEBS and Neighbourhood Environment Scale. Appropriateness of the items was based on the following criteria: (a) skewness ($\pm 2$), (b) kurtosis ($\pm 2.5$), (c) Mardia’s coefficient $[< p (p + 2), p = number of instrument items]$, (d) factor loadings ($>0.40$), and (e) correlation matrix ($<0.90$) (11,22). Additionally, the Cronbach’s $\alpha$ coefficient was used to estimate internal consistency (11).
SEM

SEM employing maximum likelihood estimation and bootstrapping procedures was performed to test the structural models’ fit (11,21). In particular, the social cognitive model (Figure 1) specified direct effects of past PA on current PA, ESE and friend support for PA. In turn, friend support for PA directly affected ESE, which had a direct effect on PA.

![Social cognitive structural model of PA](image)

**Fig. 1. Social cognitive structural model of PA**

Measurement models were not included to improve the clarity of the figure. Solid lines with standardized direct effects represent significant effects (* \( p < 0.05 \), ** \( p < 0.01 \)), whereas dashed lines represent insignificant effects. Age and gender provided the covariates. The values in italics present the variance of the measurement errors. PA = physical activity; SS = social support; ESE = exercise self-efficacy

Further, as Figure 2 presents, the ecological model specified a direct effect of past PA on neighbourhood environment, which in turn directly influenced both current PA and friend support for PA. Additionally, past PA provided direct effects on (a) current PA, (b) friend support for PA that directly affected ESE and (c) ESE. In turn, ESE directly influenced current PA.
Fig. 2. Ecological structural model of PA

Measurement models were not included to improve the clarity of the figure. Solid lines with standardized direct effects represent significant effects (* $p < 0.05$, ** $p < 0.01$), whereas dashed lines represent insignificant effects. Age and gender provided the covariates. The values in italics present the variance of the measurement errors. NE = neighbourhood environment; PA = physical activity; SS = social support; ESE = exercise self-efficacy.

Model fit

Assessment of models fit was based on the chi-square test ($\chi^2$), the Satorra-Bentler $\chi^2/df$ ratio and the Root Mean Square Error of Approximation (RMSEA) (11,23). Insignificant values of $\chi^2$ and values of $\chi^2/df$ ratio smaller than 3.0 indicate acceptable fit. RMSEA values lower than 0.05 represent close fit, between 0.05 and 0.08 indicate acceptable fit, whereas RMSEA values greater than 0.08 represent poor fit. Further, estimation of models fit was based on the Comparative Fit Index (CFI), Goodness of Fit Index (GFI), Incremental Fit Index (IFI) and Tucker and Lewis Index (TLI) (24,25). CFI, GFI, IFI and TLI values approximating 1.0 indicate perfect fit, values above 0.95 represent very good fit, whereas values above 0.90 indicate acceptable fit (24,25). The differences ($\delta$) between the hierarchical structural models in the $\chi^2/df$ ratio ($\chi^2_{d}/df_{d}$) and in CFI (CFI$_d$) were examined to find the model with the best fit (11). Significant differences between them in the $\chi^2/df$ ratio, and differences higher than the value of -0.01 between the models in CFI indicated significant differences. To find the differences between the models in the $\chi^2/df$ ratio the statistical software SBDIFF.EXE was used (University of Aberdeen, Aberdeen, UK).
RESULTS

Descriptive statistics and sample size calculation

In total, 79.43% of the sample participated in past PA, whereas 20.57% of the participants did not have a past PA experience. The mean value of the past PA’s years was 8.48 ± 9.04 (M ± SD). Regarding the present PA levels, 2.20% of the sample participated in light PA, 72.95% participated in moderate PA, and 24.85% participated in vigorous PA. The mean value of sedentary life was 5.57 ± 3.02 h per day (M ± SD). Table 1 presents the basic descriptive statistics of the dependent variables and Table 2 presents the socio-demographic characteristics of the sample.

Table 1

Means and standard deviations of the dependent variables.

<table>
<thead>
<tr>
<th>Variables</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>PA</td>
<td>46.79</td>
<td>14.09</td>
</tr>
<tr>
<td>ESE</td>
<td>3.65</td>
<td>0.85</td>
</tr>
<tr>
<td>Friend support for PA</td>
<td>2.60</td>
<td>0.91</td>
</tr>
<tr>
<td>Neighbourhood environment</td>
<td>2.68</td>
<td>0.58</td>
</tr>
</tbody>
</table>

PA = physical activity; ESE = exercise self-efficacy.
### Table 2
*Participants’ socio-demographic characteristics.*

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>206</td>
<td>30.1</td>
</tr>
<tr>
<td>Women</td>
<td>478</td>
<td>69.9</td>
</tr>
<tr>
<td><strong>Educational level</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elementary school</td>
<td>11</td>
<td>1.6</td>
</tr>
<tr>
<td>Secondary school</td>
<td>34</td>
<td>4.9</td>
</tr>
<tr>
<td>Pre-university studies</td>
<td>190</td>
<td>27.8</td>
</tr>
<tr>
<td>Professional school</td>
<td>103</td>
<td>15.1</td>
</tr>
<tr>
<td>Bachelor – University studies</td>
<td>282</td>
<td>41.2</td>
</tr>
<tr>
<td>Master / PhD studies (post-graduate)</td>
<td>64</td>
<td>9.4</td>
</tr>
<tr>
<td><strong>Civil status</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td>324</td>
<td>47.4</td>
</tr>
<tr>
<td>Married</td>
<td>310</td>
<td>45.3</td>
</tr>
<tr>
<td>Divorced</td>
<td>40</td>
<td>5.9</td>
</tr>
<tr>
<td>Widowed</td>
<td>10</td>
<td>1.4</td>
</tr>
<tr>
<td><strong>Type of job</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unemployed</td>
<td>178</td>
<td>26.0</td>
</tr>
<tr>
<td>No job (household etc.)</td>
<td>41</td>
<td>6.0</td>
</tr>
<tr>
<td>Job in private sector</td>
<td>176</td>
<td>25.7</td>
</tr>
<tr>
<td>Job in public sector</td>
<td>122</td>
<td>17.8</td>
</tr>
<tr>
<td>Independent job</td>
<td>86</td>
<td>12.7</td>
</tr>
<tr>
<td>Retired</td>
<td>81</td>
<td>11.8</td>
</tr>
<tr>
<td><strong>Monthly income (euros)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 1000</td>
<td>214</td>
<td>31.4</td>
</tr>
<tr>
<td>1000-2000</td>
<td>263</td>
<td>38.6</td>
</tr>
<tr>
<td>2000-4000</td>
<td>146</td>
<td>21.4</td>
</tr>
<tr>
<td>&gt; 4000</td>
<td>59</td>
<td>8.6</td>
</tr>
</tbody>
</table>
Further, initial analysis indicated non-normal distributions for the past and current PA indexes. Therefore, to solve the problem of non-normal distributions square root and logarithmic functions were conducted (11). With regard to the sample size, the ratio of participants’ number to observed variables was higher than the 10:1 ratio, as it was 48.86:1 for the social cognitive model, and 38:1 for the ecological model. In line with this, the number of participants was higher than the recommended sample size for both models’ structure (\( N_{\text{soc/cognitive}} = 400 \), \( N_{\text{ecological}} = 256 \)) and significant effects’ identification (\( N_{\text{soc/cognitive}} = 152 \), \( N_{\text{ecological}} = 290 \)).

**CFA results**

**ESE Scale**

The Mardia’s coefficient (2.87) of the scale showed multivariate normality. The results supported the factorial validity of the scale (\( \chi^2 = 16.668, df = 5, p = 0.005 \), \( \chi^2/df = 3.334, CFI = 0.993, GFI = 0.990, IFI = 0.993, TLI = 0.987, RMSEA = 0.058 \)). The Cronbach’s \( \alpha \) was 0.88.

**FrSEBS**

The Mardia’s coefficient (1.29) of the FrSEBS supported multivariate normality. The measurement model provided an appropriate fit (\( \chi^2 = 84.837, df = 5, p = 0.000 \), \( \chi^2/df = 16.967, CFI = 0.964, GFI = 0.949, IFI = 0.964, TLI = 0.929 \)). However, the RMSEA value (0.153) was high. An alternative model was examined setting a pair of correlated errors between items 3 and 4, based on their conceptual similarity. The alternative model represented a better fit (\( \chi^2 = 12.738, df = 4, p = 0.013 \), \( \chi^2/df = 3.185, CFI = 0.996, GFI = 0.992, IFI = 0.996, TLI = 0.990, RMSEA = 0.057 \)). This finding was verified by the differences between the models in CFI (\( CFI_D = -0.03 \)) and \( \chi^2/df \) ratio (\( \chi^2_D = 8.01, df_D = 1, p < 0.05 \)). The Cronbach’s \( \alpha \) was 0.88.

**Neighbourhood Environment Scale**

The Mardia’s coefficient (3.04) of the scale indicated multivariate normality. The results supported an adequate factorial validity (\( \chi^2 = 13.948, df = 4, p = 0.007 \), \( \chi^2/df = 3.487, CFI = 0.988, GFI = 0.992, IFI = 0.988, TLI = 0.970, RMSEA = 0.060 \)). The Cronbach’s \( \alpha \) was 0.76.

**Structural models’ fit**

The Mardia’s coefficients for both the social cognitive (8.16) and the ecological (17.48) models indicated multivariate non normality. Therefore, SEM was conduct-
ed using bootstrapping with the Bollen-Stine approach to assess model fit under non normal conditions (11).

In particular, the social cognitive model provided an appropriate fit ($\chi^2 = 78.249$, $df = 73$, $p = 0.005$, $\chi^2/df = 1.072$, $CFI = 0.967$, $GFI = 0.956$, $IFI = 0.967$, $TLI = 0.959$, $RMSEA = 0.056$) adjusting for age and gender. The model accounted for 40% of the variance in PA. As figure 1 presents, past PA positively affected current PA ($0.52$, $p < 0.01$), friend support for PA ($0.18$, $p < 0.01$) and ESE ($0.28$, $p < 0.01$). Friend support for PA insignificantly influenced ESE. In turn, ESE had a positive effect on PA ($0.21$, $p < 0.01$). Regarding the covariates, age negatively affected PA ($-0.11$, $p < 0.05$), whereas gender insignificantly affected PA. The total standardized effect of past PA on current PA was 0.58, indicating that an increase of 1 $SD$ on past PA predicts an increase of 0.58 $SD$ on current PA.

Further, the ecological model represented an adequate fit ($\chi^2 = 154.193$, $df = 145$, $p = 0.005$, $\chi^2/df = 1.063$, $CFI = 0.969$, $GFI = 0.954$, $IFI = 0.969$, $TLI = 0.963$, $RMSEA = 0.042$), while controlling age and gender. The model accounted for 40% of the variance in PA. As figure 2 shows, past PA positively influenced current PA ($0.52$, $p < 0.01$), neighbourhood environment ($0.09$, $p < 0.05$), friend support for PA ($0.17$, $p < 0.01$) and ESE ($0.28$, $p < 0.01$). Neighbourhood environment had positive effects on friend support for PA ($0.14$, $p < 0.05$) and PA ($0.08$, $p < 0.05$). Friend support for PA insignificantly affected ESE, which in turn provided a positive effect on PA ($0.21$, $p < 0.01$). Considering the covariates, age negatively affected PA ($-0.11$, $p < 0.05$), whereas gender insignificantly affected PA. The total standardized effect of past PA on current PA was 0.58, indicating that when past PA increases by 1 $SD$ current PA increases by 0.58 $SD$.

With regard to the comparisons between the aforementioned models in fit, there were insignificant differences between them based on both $CFI$ ($CFI_D = -0.002$) and $\chi^2/df$ ratio ($p > 0.05$).

**DISCUSSION**

This study examined the causal relationships between participation in past PA and the current PA levels, as well as, among past PA, neighbourhood environment and baseline PA within the context of theoretical frameworks. In particular, the selection of the models’ variables was based on the social cognitive and ecological theories strengthening the research purpose for identifying effects and interactions among them. In addition, an original aspect of the current study was the investigation of the effects of past PA, ESE, friend support for PA and neighbourhood environment on PA within the context of the same theoretical model, as well
as, the comparison of two structural models explaining the PA participation. Such associations have not been reported so far in the literature.

The current study demonstrated that adults who participated in past PA and felt confident enough with regard to their ability to persist in exercising had high PA levels in present. Therefore, the important effect of past PA experience on current PA was supported. This finding indicated that to enhance adults’ participation in PA specialists should focus on promoting PA through lifespan, as it seems that PA is a relatively stable lifestyle characteristic from adolescence to adulthood and old age (6,7). In particular, to maintain high PA levels through lifespan socialization to a physically active way of life should begin early in childhood. Regarding ESE, which is a basic social cognitive theory concept, it appeared to be the most important mediator in the relationship between past and current PA. This result indicated that to increase PA levels interventions should promote one’s belief in his/her ability to persist in exercising. One of the ways to enhance ESE is to create successful experiences and positive feelings during PA and to promote self-regulatory techniques such as setting behavioral goals and prompting self-monitoring of behavior (26,27). Another way to increase ESE is to maintain a continuity of PA through lifespan, as it was supported from the positive effect of past PA on ESE found in this study.

Further, the current research suggested that environmental factors, such as access to sidewalks, parks and sport facilities, enhanced adults’ participation in PA. This finding, which is in accordance with the results of previous studies (8-10) supported that ecological models could be used in promoting PA as it seems that environmental variables modulate PA. However, in this study, the examined ecological model accounted for the same percentage of the variance in PA, as the social cognitive model, with insignificant differences between them. A possible explanation is that the association between environment and PA may be confounded by psychosocial variables (8). In addition, it seems reasonable that the PA behaviour most likely to be influenced by environment is walking compare to PA taking place indoors.

Finally, this study had several limitations that need to be reported. First, due to the cross-sectional nature of the study, such data are not optimal for assuming causality over time (11). In particular, the proportion of the total effect mediated by mediators is often misleading. However, the hypothesized models were based on a sufficient theoretical background, and they could be assessed within a cross-sectional framework for identifying associations among the examined factors. Second, measures were self-reported and problems associated with common method variance should be considered. Third, the years’ number of participation in past PA was recorded as past PA not including questions about type and months. Fourth, objective measures of PA through accelerometers, as well as, environment through geographical information systems technology were not used.
Despite the apparent limitations, this study had some advantages that should be taken into account. Particularly, a key feature of this study was the investigation of the relationship between past and current PA through the intermediary effects of ESE, neighbourhood environment and friend support for PA that has not been examined until now. Further, the comparison of two theoretical models explaining the PA levels was an original aspect of this research.

**CONCLUSION**

In this study, the association between past and current PA was examined. Specifically, past PA and ESE appeared to have the most important positive effects on PA indicating the existence of a continuity of PA behaviour through lifespan, as well as, the role of beliefs in one’s ability to persist with exercise in the PA maintenance. In addition, the current study proposed that an effective neighbourhood environment for PA promotion could be used for enhancing PA. Considering the limitations of the study, future studies should be carried out to examine the structural models using longitudinal data for better understanding the interactions and relations of the examined variables over time. Finally, similar studies using objective assessments of PA and neighbourhood environment would be of considerable value.

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