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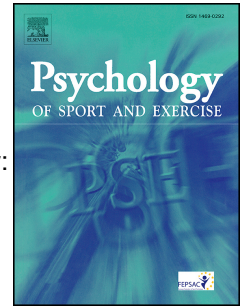


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Socioeconomic status as a moderator between physical activity and social cognitions:

Systematic review and meta-analysis based on the Theory of Planned Behavior

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### **Abstract**

**Background:** Health inequalities are to a substantial degree due to socioeconomic status (SES) related differences in health behaviors such as physical activity. However, little is known about the role SES plays in the self-regulation of physical activity.

**Purpose:** This systematic review with meta-analysis examines whether a comprehensive set of indicators of SES (income, education, occupational status) impacts on the behavioral self-regulation by moderating the relationships between social cognitions in the Theory of Planned Behavior (TPB) and physical activity.

**Methods:** A systematic literature search identified 94 studies from 83 articles that provided information on sample SES and correlations between TPB variables and physical activity.

Random-effects meta-analyses were used to pool correlations corrected for sampling and measurement error. Random-effects meta-regression was used to examine moderating effects of study-level SES on these correlations.

**Results:** Education moderated the relationship between intentions and physical activity, such that studies with better educated samples reported stronger intention-physical activity relationships.

**Conclusions:** These results suggest that education might play a major role in the self-regulation of physical activity, with better educated samples more likely to translate intentions into behavior. This can both help to explain heterogeneity in the relation between intentions and physical activity as well as support the development of more effective interventions targeting intentions and physical activity.

### **Key words**

Physical activity; Socioeconomic status; Meta-analysis; Systematic review; Theory of Planned Behavior; Meta-regression

Regular physical activity has countless benefits for one's health – for example, engaging in moderate physical activity substantially reduces the risk for breast cancer (risk reduced by 75%), cardiovascular and heart disease (49%), diabetes (35%), and colorectal cancer (22%) (Kruk, 2007). However, representative data from industrialized countries indicates that for example in Australia, 60% of adults fail to meet activity recommendations, and 30% engage in more sedentary behavior than recommended (Australian Institute of Health and Welfare, 2012). This data and similar surveys from other industrialized nations such as the US (Centers for Disease Control and Prevention, 2014) and from emerging nations such as China (Chen et al., 2015) however also emphasize the fact that physical activity/inactivity is not equally distributed along the spectrum of socioeconomic status (SES) (Gidlow, Johnston, Crone, Ellis, & James, 2006).

Socioeconomic status is usually conceptualized as the social standing or class of an individual or group in the social hierarchy (American Psychological Association, 2007). Differences in SES indicate the difference in access to resources which affect individuals' ability to engage in different healthy (or unhealthy) behaviors, in particular physical activity (Gidlow et al., 2006). In addition, SES can influence an individual's social cognitions related to health behaviors, such as intentions, self-efficacy or perceived behavioral control, attitudes or even executive functioning (Blair & Raver, 2012). SES can be measured at both an area (for example, composite are indicators of deprivation) or at an individual (for example education, occupation and income) level (Shaw et al., 2007). Individual-level measures might be more sensitive in examining SES effects on behavior, as they show greater association with health outcomes than area-based measures, which may mask significant heterogeneity amongst populations (Pardo-Crespo et al., 2013). This systematic review with meta-analysis aims to summarize the role of individual level measures of SES in the self-regulation of physical activity within the framework of the Theory of Planned Behavior (Ajzen, 1991).

### Facets of Individual Socioeconomic Status and Physical Activity

Different aspects or facets of socioeconomic status, in particular education, income, and occupational status have been shown to affect health via different pathways and to different extents (Geyer, Hemström, Peter, & Vågerö, 2006).

Regarding *income*, reviews suggest that disposable income can restrict or facilitate access to physical activity opportunities (Giles-Corti & Donovan, 2002). Further, income determines where people live – areas with high proportions of low-income residents often have less access to, and poorer overall, facilities that might encourage people to be physically active (Evans, Jones-Rounds, Belojevic, & Vermeulen, 2012).

Higher levels of *education* will enhance a person's ability to search for, understand, and interpret health-related information (Goldman, Turra, Rosero-Bixby, Weir, & Crimmins, 2011). Individuals with higher levels of education might be able to make better informed decisions about benefits or risks associated with physical activity, and make better structured and more realistic plans for activity (Allan, Sniehotta, & Johnston, 2013). Higher levels of education will also enable individuals to gain better access to resources that might facilitate physical activity and thus indirectly influence physical activity (Goldman et al., 2011), and accordingly individuals with higher educational attainment seem to engage in higher levels of physical activity (e.g., Murakami et al., 2011).

Regarding *occupation*, people in full-time employment are more physically active than those employed part-time or unemployed (Van Domelen et al., 2011). There is also evidence that being employed in a higher-status occupation is associated with more leisure-time physical activity (Kirk & Rhodes, 2011; Trost, Owen, Bauman, Sallis, & Brown, 2002). Higher-status occupations could both be associated with higher incomes, and with more flexible time arrangement that facilitate people's access to leisure facilities and opportunities to engage in physical activity.

While there is good evidence for SES gradients in physical activity, most research to date does not explore pathways linking SES to physical activity. This review aims to examine whether SES might affect individual behavioral self-regulation, that is, in the relations between social cognitions and physical activity, which could help explain the different levels of activity according to SES.

### **Social-Cognitive Determinants of Physical Activity and Socioeconomic Status**

The Theory of Planned Behavior (TPB) (Ajzen, 1991) and the Reasoned Action Approach (RAA) (Fishbein & Ajzen, 2010) incorporate many of the key determinants of health behaviors such as physical activity and propose that behavior is directly predicted by behavioral intentions, whereas the influence of other cognitions, in particular attitudes, subjective norm, and perceived behavioral control is mediated through intentions (with a residual direct effect of perceived behavioral control on behavior). Both the TPB and RAA have been widely used to examine physical activity (Hagger & Chatzisarantis, 2009; McEachan, Conner, Taylor, & Lawton, 2011; McEachan et al., 2016), which provides a substantial database of studies that have employed similar means to measure key health cognitions, ideal for review purposes.

The key assumption of the present review is that SES facets act as moderators of the relations between TPB variables and physical activity, that is, as factors that determine the degree to which these variables are associated with physical activity. In particular the relationship between intentions and physical activity is likely to be affected by SES. As noted above, income and occupational status might facilitate access to activity, which could lead to greater effects of intention on activity. This assumption is supported by at least two previous studies that found higher intention-activity relations in participants with higher income (Amireault, Godin, Vohl, & Pérusse, 2008; Pan et al., 2009), but see Vasiljevic et al. (2015) as an example to the contrary. With regard to education, higher educational attainment



has been linked to more stable intentions for physical activity (Godin et al., 2010), which in turn have been associated with higher intention-behavior relations. Two recent studies report conflicting findings on moderating effects of occupational status on the intention-activity relation. Conner et al (2013) find the relationship between intentions and physical activity to be closer in individuals with higher-status professions, whereas Vasiljevic et al. (Vasiljevic et al., 2015) found no moderating effects of occupational status.

With regard to perceived behavioral control, at least one study suggests moderating effects of income (Amireault et al., 2008): Here, the effects of control on activity are higher in participants with higher incomes. One study (Schüz et al., 2012) further found the relation between attitudes and physical activity to be moderated by area-level SES. Taken together, these studies suggest that SES might moderate the relation between social cognitions as outlined in the TPB and physical activity, but at the same time report heterogeneous findings that warrant a more thorough examination of the role of SES in the relationship between social-cognitive predictors of physical activity and activity.

### **Aims and Research Questions**

The aims of the present review therefore are to explore the moderating role of the SES facets of income, education, and occupational status on behavioral self-regulation as indicated by the relations between TPB variables and physical activity. Conducting a systematic review based on the Theory of Planned Behavior will allow us to utilize the information from the numerous existing studies reporting the associations between social-cognitive predictors of physical activity and activity while at the same time retaining a homogeneous set of social-cognitive predictors with comparable assessments. The meta-analytic approach of this study which combines meta-analysis with meta-regression will allow us to find out whether differences between studies in the associations between TPB variables and physical activity can be accounted for by the different facets of socioeconomic

status the samples in the studies.

## Method

A systematic review with meta-analysis was conducted. The reporting of the review is based on the PRISMA (Moher et al., 2009) statement (Supplemental Material 1).

### Literature Search

The literature search for this study focused on updating the most recent systematic review on the prediction of health-related behaviors using the Theory of Planned Behavior (McEachan et al., 2011), which included studies up to 2010. Eighty-eight [88] studies from McEachan et al.'s (2011) review examined physical activity and therefore were used in the current review. We then applied the same search terms as those used in McEachan et al.'s (2011) review to search for literature from 2010 on (ceasing in August 2016). We added search terms specifying any kind of physical activity and searched two interdisciplinary electronic databases (*Scopus* and *Web of Science*) for combinations of these terms: (1) attitude\* and norm\* and control and intention\*; (2) "theory of planned behavi\*"; (3) "planned behavi\*" and Ajzen; (4) activity or exercise\* or walk\* or run\* or jog\* or golf\* or tennis or swim\* or soccer or sport or athlet\* or aerobic\*, and (5) published 2010 or after. This search yielded 1,235 hits in *Scopus* and 489 in *Web of Science*. After the removal of duplicates, 1,459 articles remained. Combined with the 88 studies in McEachan et al. (McEachan et al., 2011), 1,547 studies were available for review. The full search syntax is available as supplement 2.

### Inclusion Criteria

Studies were eligible for inclusion in the present review if they met the following inclusion criteria: (a) reporting at least one correlation between the TPB factors (attitudes, subjective norm, perceived behavioral control, intention) and behavior; (b) outcome measures were frequency measures of any kind of physical activity; (c) participants were adults (over

18 years), and (d) providing information about the socioeconomic status of the sample of the study as either education, income, or occupational status. If more than one article was published from the sample of participants, the study with the longer time frame was included in the meta-analysis.

Abstracts were independently coded by SLW and AH, with a satisfactory inter-rater reliability of  $\kappa = .73$ . Applying the inclusion and exclusion criteria to study abstracts, 1060 studies were excluded, and full-texts of 342 articles were retrieved. Differences were resolved through discussions between BS, SLW, and AH. Full-text articles were further screened for inclusion and exclusion criteria, with a further 254 studies excluded (mainly for not providing SES information). The corresponding authors of studies that met inclusion criteria but did not report all correlations required for the meta-analysis were contacted via email and received up to three reminders. After these steps, a final sample of 88 articles (50 of those sourced from McEachan et al., 2011) with  $k = 99$  studies met all inclusion criteria and accordingly was included in the meta-analysis. Supplemental Material 3 contains a list of all studies in the meta-analysis and key study characteristics.

Figure 1 about here

### **Coding and Data Extraction**

Means, standard deviations, reliability, type of assessment (self-report vs. accelerometer/attendance data) and intercorrelations between Theory of Planned Behavior variables and physical activity were recorded along with the sample sizes for these correlations. In longitudinal studies and studies with repeated assessments of either variables, length of follow-up (if applicable) was recorded. We also extracted the country of the study, age, and sex composition of the sample.

### ***Extraction of Socioeconomic Status Data***

Socioeconomic status information about the study samples was extracted regarding

education, income, and occupational status. To be able to compare socioeconomic status both within categories and between categories, the information on each SES facet of the study sample was transformed into a point score using the scoring system developed by the German Federal Robert Koch Institute (Lampert, Kroll, Müters, & Stolzenberg, 2013). This system operationalizes SES as education, income and occupational status. These dimensions are then ranked on metric scales with a weighting between 1 and 7 based on their predictive value for income categories. Importantly, we coded study sample SES based on the majority or modal value of the sample, i.e., a sample with 51% university students was coded as “university students” and awarded the respective score.

The scoring of education in this system is based on the categories of the Comparative Analyses of Social Mobility in Industrialized Nations (CASMIN) (Brauns, Scherer, & Steinmann, 2003), and each CASMIN category is allocated a point score (e.g., a sample consisting of majority current university students was awarded as 4.8, and a sample with a majority of university graduates was coded as 6.1).

In order to be able to code income, the mean income of the study sample into a percentile rank based on archival national income distributions. This means that for example a study that was conducted in Canada in 2008, the percentile rank of the sample was determined by comparing the average study income to the Canadian household income distribution from 2008. These percentiles were then coded in points according to the Lampert et al. scoring system – for example, a sample average income on the 57<sup>th</sup> percentile of the archival national income distribution was awarded 3.99 points.

Occupational status was coded according to the International Socio-Economic Index of Occupational Status (Ganzeboom & Treiman, 1996). For example, a sample consisting of a majority of clerical and workers was awarded 4.2 points.

As the indicators used in this coding system have been criticized for a lack of

equivalence between countries (Schneider, 2010), and as the points are based on a relatively arbitrary criterion, we additionally coded study samples as high/low education, income and occupational status categories based whether they fell above or below the median of the overall distribution of this variable across study samples.

### **Meta-analytic strategy**

The effect sizes most frequently reported in the studies or data received from corresponding authors were zero-order correlations. These correlations were transformed using the Fisher z-transformation, with weights derived from the sample size of each test. A random-effects meta-analysis was run in order to account for the notion that the true effect size in the underlying population might differ as a function of study heterogeneity. In order to examine this heterogeneity between studies, Cochran's  $Q$  and  $I^2$  statistics were examined. Significant  $Q$  statistics ( $Q$  follows a  $\chi^2$  distribution) indicate significant heterogeneity in the effect sizes.  $I^2$  indicates the percentage of variability in the effect sizes (correlations) that are due to true differences rather than chance. We followed tentative cut-offs for  $I^2$  (Higgins, Thompson, Deeks, & Altman, 2003) by interpreting 25% as low, 50% as moderate, and 75% as indicating high heterogeneity.

The meta-analytic strategy involved three steps – first, transforming all effect sizes into a common metric using Fisher's z-transformation. Second, a random-effects meta-analysis was performed on all correlations within the TPB to obtain overall effect sizes and estimates of heterogeneity between studies. The third step examined moderating effects of SES by conducting meta-regressions to estimate the effects of study-level SES indicators on the pooled relationships between each TPB variables and physical activity. In these analyses, the intercepts of the study-specific effect sizes (e.g., correlation between intentions and behavior) were regressed on study-level indicators of all SES facets (education, income, occupational status). As the effect sizes per study are estimates based on the specific study

populations, meta-analytic models with random effects were estimated using restricted maximum likelihood estimation. We adjusted the moderator analyses for Type I error and power by using the Knapp and Hartung adjustment to the standard error (Viechtbauer, López-López, Sánchez-Meca, & Marín-Martínez, 2015). Risk of bias due to small samples in all analyses was examined by testing for funnel plot asymmetry, where significant asymmetry would indicate a relationship between sample size and effect size (in particular overly large effect sizes in smaller studies). All analyses were performed in R (R Development Core Team, 2010) using *metafor* (Viechtbauer, 2010).

## Results

### Study characteristics

Overall, 88 articles with  $k = 99$  studies provided relevant information and were included in the meta-analysis (Complete reference list in online supplemental material 3). Sample sizes ranged between 35 (Taut & Baban, 2012) and 1,280 (Chaney, Bernard, & Wilson, 2013). The studies originated from 11 different countries, with the UK ( $n = 31$ , 31.3%), Canada ( $n = 28$ , 28.3%) and the US ( $n = 23$ , 23.2%) accounting for the vast majority of studies. Ninety studies (90.9% of the total sample of studies) provided information on the educational status of the sample, income information was available from 19 (19.2%) studies, and occupational status of the sample was reported in 5 studies (5.1%). Overall, 14 studies (14.14%) provided information on more than one SES indicator. Regarding education, 63 out of the 99 studies (63.63%) were conducted in undergraduate students, thus the overall distribution of educational status of the samples was skewed towards better educated and younger samples. Regarding income, most study samples were above the income median of their countries in the year of study, indicating a skew towards more affluent samples. Regarding occupation, most studies reported no specific occupation of their samples, but

provided information on the employer, which allowed us to refer back to the skills performed by employees.

Risk of bias assessments were conducted by examining the studies on key quality characteristics for correlational studies: Sample selectivity, i.e., the degree to which the sample was based on a single population group (higher risk of bias, 63.6% of studies) or based on a community or representative sample (lower risk of bias, 36.4% of studies); Study design (longitudinal vs. cross-sectional, with studies over 8 weeks lag deemed lower risk of bias (McEachan et al., 2011) (25% of studies), studies between 1 and 7 weeks deemed medium risk of bias (59.78% of studies), and cross-sectional studies deemed higher risk of bias (15.21% of studies); and assessment of the dependent variable (physical activity), with objective measures deemed as lower risk of bias (11.1% of studies), validated self-reports deemed a medium risk of bias (61.6% of studies), and non-validated self-reports deemed a higher risk of bias (27.3% of studies). See supplementary material 4 for a summary graph on risk of bias.

### **Theory of Planned Behavior Variables and Physical Activity**

In the first step of the meta-analysis, the relations between attitudes, subjective norm, perceived behavioral control as well as intentions and behavior were examined. All TPB variables were significantly and positively associated with physical activity. Consistent with TPB assumptions, intention had the strongest associations with physical activity,  $r_z = .50$ , a large effect size according to Cohen (Cohen, 1988). The association between perceived behavioral control and behavior has a medium effect size,  $r_z = .36$ , as has the association between attitude and physical activity,  $r_z = .30$ . Subjective norm had the weakest associations with physical activity,  $r_z = .17$ . All tests for funnel plot asymmetry were not significant, with the largest  $z$  (-1.86) for the relation between norms and physical activity, indicating a low risk of bias due to small sample size and no need for trim-and-fill-analyses. More detail as well as

Forest and funnel plots for these associations can be found in Supplemental Material 5. All associations showed significant heterogeneity between studies, with all  $Q$  statistics being significant. The  $I^2$  statistics suggested that the associations between all TPB variables and physical activity showed high heterogeneity according to (Higgins et al., 2003).

Table 1 about here

### **Moderator Analyses: Meta-Regressions with Socioeconomic Status Indicators**

In the following steps, we conducted meta-regressions with the different socioeconomic status indicators (income, education, occupational status, overall SES indicators) as study-level predictors of the effect sizes obtained in the random-effects meta-analyses.

#### ***Income***

In the first set of meta-regressions, we regressed the study-level effect sizes ( $z$ -transformed correlations between intentions, as well as perceived behavioral control, attitude, subjective norm and physical activity) on income for those studies that provided income information ( $k = 19$ ). These studies had a mean score of 3.61 ( $SD = 0.92$ ) income points (Lampert et al., 2013). Table 1 shows that income did not significantly predict the size of the correlation between any of the TPB variables and physical activity, and further, that income did not significantly reduce the heterogeneity between the studies (non-significant  $Q_M$  statistics), nor explain any variation in the relations between the TPB variables and behavior, as indicated by the  $R^2$  values of zero.

To test this moderator effect independent of the coding system used, we also regressed the study-level correlations on an indicator of low/high income based on the median split of the sample income distribution. These analyses produced essentially identical results, with no significant moderator effects of income and no significant reduction in the heterogeneity between studies (Figure 1; supplemental material 6). None of the tests for



forest plot asymmetry emerged significant, indicating no undue influence of studies with small samples and no need for trim-and-fill-analyses.

### **Education**

In the second set of meta-regressions, we examined whether the educational status of the study samples predicted the size of the correlations between the TPB variables and physical activity. In total,  $k = 90$  studies provided information on the educational status of the sample, with a mean of 4.54 ( $SD = 0.65$ ) points (Lampert et al., 2013). Table 1 shows that sample education significantly moderated the relation between intentions and behavior, with studies with better educated samples showing stronger correlations between intention and behavior. The meta-regression coefficient of  $B = 0.16$  indicates that a study with a sample that had an educational status one unit higher was predicted to have a .16 units higher Fischer's  $z$ -transformed correlation between intentions and behavior. Education significantly reduced the heterogeneity between studies (significant  $Q_M$  statistic) and explained 21.99% in the between-studies variance. Note that the estimate of the intercept (population average) of the correlation between intentions and behavior is estimated at  $r_z = -0.27$ , because the lowest point score awarded to any study sample was 2.8.

Education did not significantly moderate any of the relationships between physical activity and perceived behavioral control or attitudes (non-significant  $Q_M$  statistics), but was a marginally significant moderator of the subjective norm – activity relationship, explaining 3.43% of the heterogeneity in this relationship. or subjective norm. However, on inspection, this effect was mainly due to one outlier study (Hsu, Hsu, & Lin, 2016) that reported a very high correlation (0.72) between subjective norm and behavior together with relative low educational attainment of the sample.

Similar to the analyses on income, we also examined whether a median-split based dichotomous indicator of high (coded 1) vs. low (coded 0) sample education status

significantly moderated the correlations between health cognitions and physical activity (supplemental material 6) and found that this indicator also moderated the intention-physical activity relation with Fischer's z-transformed correlation between intention and physical activity being estimated at .54 in samples with higher education and .29 in samples with lower education (Figure 1). Similar to the analyses using education points, we also found education to moderate the subjective norm – physical activity relationship, but this moderator effect was reduced to non-significance after removing the Hsu et al. (2016) study. None of the tests for forest plot asymmetry emerged as significant, indicating no undue influence of studies with small samples and no need for trim-and-fill-analyses.

As the majority of the studies reporting education were conducted in undergraduate students, we ran an additional analysis to rule out that this moderator effect was carried by third variables that might also characterize this group rather than education. We ran a multiple random-effects meta-regression controlling for both age and sample heterogeneity to control for effects of lower-age and homogeneous student populations. In this analysis, education remains a significant moderator of the intention-physical activity relation ( $B = .13$ ,  $p = .01$ ), with neither sample age ( $B = .06$ ,  $p = .59$ ) nor sample homogeneity ( $B = .16$ ,  $p = .09$ ) significantly moderating the intention-activity relation.

Figure 2 about here

### *Occupational status*

Occupational status was not examined as stand-alone indicator of SES, as only 5 studies provided information on occupational status, with 4 studies being coded with identical scores (Lampert et al., 2013), which renders moderator analyses uninterpretable. The studies with higher occupational status reported correlations between intentions and activity ranging between  $r = .08$  and  $r = .84$ , whereas the one study with lower occupational status reported  $r = .65$ .

## Discussion

This systematic review and meta-analysis with meta-regression explored whether the relations between health cognitions and physical activity was moderated by socioeconomic status. Based on a three-facet model of socioeconomic status (education, income, occupational status), the socioeconomic status of the samples of 99 studies on physical activity and the TPB was coded, both using a 7-point coding system per facet (Lampert et al., 2013) and a dichotomous high vs. low indicator per facet based on a median split. The main findings were that education moderated the relationship between intention and physical activity, with higher correlations found in studies with better educated samples. The SES facet of income did not moderate model relationship, and there were insufficient studies to examine the moderating effects of occupational status.

### Education as Moderator of TPB – Physical Activity Relations

We found that education moderated relationships between intention and physical activity when assessed both as a continuous and a dichotomous indicator such that better educated samples demonstrated stronger relationships. This suggests that better education facilitates the translation of intentions into action, and that lower education poses a barrier for this. We found no significant moderator effects of education for relations between physical activity and attitudes, subjective norm, or perceived behavioral control. This finding could suggest that the degree to which individuals translate their intentions for physical activity into behavior could be one of the mechanisms linking better educational attainment to higher levels of physical activity (Murakami et al., 2011) and ultimately to better health (Barboza Solís et al., 2016). As the majority of the studies reporting education were conducted in undergraduate students, we ran an additional analysis to rule out that this moderator effect was carried by third variables that might also characterize this group rather than education. We ran multiple random-effects meta-regressions controlling for both age and intention

reliability (as a proxy indicator of the fact that undergraduate students are more familiar with filling in questionnaires; Online Supplemental Material 8). This analysis shows that education remains a significant moderator of the intention-physical activity relation even when controlling for sample age and intention reliability.

Previous studies examining the impact of education on the relation between intentions and physical activity have yielded conflicting results, with two studies (Pan et al., 2009; Vasiljevic et al., 2015) indicating no moderating effects of a dichotomous indicator of education on the intention-behavior relationship. On the other hand, a moderated mediation analysis (Godin et al., 2010) found education to significantly moderate the intention-physical activity relationship in the same manner as the present review. Godin et al. also provide a test of a potential mechanism by which education might affect this relationship; in their study, people with higher education formed more stable intentions, which in turn were more predictive of behavior change. It has been argued that intention stability is an indicator of the resilience of intentions against external influences that might impact on behavior in that people with more stable intentions might have better abilities to shield their intentions against competing cognitions (e.g., temptations, cues for conflicting behaviors), in turn increasing the chance to act on intentions (Conner, McEachan, Lawton, & Gardner, 2015; Cooke & Sheeran, 2004)

A further pathway via which education might affect the relation between intentions and physical activity is the formation of implementation intentions or action plans. Previous research has shown that better cognitive resources – which are likely to result from or at least be associated from better education – predict the forming of implementation intentions that are more likely to result in behavior change than implementation intentions formed by individuals with poorer planning skills (Allan et al., 2013). Better educated individuals could therefore be better suited to translate their intentions to act into more feasible implementation

intentions, which in turn would make behavior enactment more likely. Educational attainment also makes it more likely that people will have access to tangible and intangible resources (Ross & Mirowsky, 2010), from disposable income to social support, which in turn will facilitate the translation of intentions into physical activity.

Education did not significantly moderate the relations between attitudes or perceived behavioral control and behavior. The moderating effect of education on the subjective norm-physical activity relation was identified to be due to one outlier study (Hsu et al., 2016). These overall non-significant moderator effects were contrary to our assumptions that SES might moderate these relationships based on effects for other SES indicators (Amireault et al., 2008; Schüz et al., 2012; Vasiljevic et al., 2015). However, it is consistent with the TPB/RAA view of intentions being the key proximal determinant of behavior that mediates other influences. It is also possible that such effects are masked by assessing the educational status of the study sample rather than individual educational status, as it is likely that these relations are subject to considerable individual variability. Future studies should consider reporting correlations between education and health cognitions to further research in this area.

### **Income as Moderator of TPB – Activity Relations**

Income did not moderate any relationships between TPB variables and physical activity, neither entered as points scored according to (Lampert et al., 2013) nor entered as a dichotomous variable. Previous studies examining the moderating role of income on the relation between TPB variables and physical activity have found that higher income predicts closer associations between intentions (Pan et al., 2009) as well as perceived behavioral control and physical activity (Amireault et al., 2008). This inconsistency could both be due to the income distributions of the samples in the studies examined in the review and to substantial within-studies heterogeneity according to income, but also to a less important role

of disposable income in realizing physical activity from social cognitions as outlined in the TPB. Future studies are needed that examine potential moderating effects of individual income on intention-activity relations in order to be able to draw conclusions on whether there is a moderator effect or not. Further, as most studies that reported income used the Godin Leisure Time Exercise Questionnaire (Godin & Shephard, 1985) or similar instruments that measure total time spent in activity rather than providing scores for specific activities, participants might have engaged in physical activities that are less dependent on financial resources such as running, which in turn would suggest that income could not moderate this relationship.

### **Occupation as Moderator**

We had assumed, in line with previous studies (Conner et al., 2013; study 3), that occupational status could moderate the relationship between TPB variables, in particular intention, and physical activity. However, the sample of studies for this review were too limited in the descriptions of the occupational status of the sample to conduct valid and interpretable moderator analyses. While it is entirely possible that features of specific occupations, e.g., less fixed time constraints, which allows participating in activity, could facilitate the translation of intentions into behavior (Kirk & Rhodes, 2011; Panter, Griffin, Jones, Mackett, & Ogilvie, 2011), better reporting of the occupational status in future studies is required in order to allow for such analyses.

### **Individual vs. context-based socioeconomic status**

As mentioned above, there were no moderator effects for individual income in the relationship between any TPB variable and physical activity, which seems to suggest that deprivation (or access to resources) might be of less importance for the translation of social cognitions into behavior. However, several previous studies examining the relation between socioeconomic status and health behavior (Conner et al., 2013; Giles-Corti & Donovan,

2002; Godin & Shephard, 1985; Vasiljevic et al., 2015) have in fact examined area-level deprivation that was matched to individuals via post codes. This procedure does not account for the fact that people are nested within the areas that they live in, and thus clustering needs to be accounted for in random-effects models (Schüz, in press). Indeed, previous research examining area-level deprivation taking into account clustering has found that area-level indicators of SES moderate the relationships between social cognitions and physical activity (Carlson et al., 2012; Schüz et al., 2012). This points to the importance of barriers and facilitators of behavior in one's direct surroundings (see also the concept of risk regulators (Glass & McAtee, 2006) or environmental press (Lawton, 1983)), but so far, only relatively few studies have examined direct interactions between indicators of socioeconomic status and individual social-cognitive determinants of health behaviors (Schüz, in press). However, this review could not examine the role of environmental resources and barriers as moderators of TPB-activity relations, as no study provided information that would have allowed coding this indicator of socioeconomic status.

### **Limitations and Directions for Future Research**

As for all systematic reviews, this review is subject to potential limitations arising from its search strategy, but it was crucial to make this research comparable to a previous systematic review (McEachan et al., 2011) in order to build on this evidence base. Second, although substantial efforts were made to obtain correlation matrices from studies that had not provided these matrices in the article, not all follow-up attempts were successful, which might have led to a biased sample. Third, even though there was a substantial number of studies available for analyses ( $k = 99$ ), these studies were predominantly drawn from undergraduate student populations, which limits the generalizability of the findings in this review. In addition, most studies came from English-speaking countries that share some societal characteristics, which also limits the generalizability of our findings beyond this

cultural background.

One limitation of this review is the potential risk of bias resulting from study selectivity, design and assessments. Most studies used self-report assessments of physical activity, which has substantial limitations with regard to recall and validity, although the majority of the studies used well-validated self-report instruments. As most of the studies used summative physical activity measures such as the Godin Leisure Time Exercise Questionnaire (Godin & Shephard, 1985), no further moderator analyses examining different types of physical activity could have been conducted. This means that the implications drawn are subject to the limitations arising from an increased risk of bias due to study quality. The samples in the studies were mostly homogeneous, and most of the samples were drawn from undergraduate student populations. However, we did control for homogeneity and age (as a proxy for student status) and still found significant moderator effects. The non-student populations in the review were partly drawn from rehabilitation samples, which further limits the generalizability of our findings. While these limitations are tied to the samples of the studies reviewed, there are also potential limitations arising from the methods used. The operationalization of socioeconomic status in three facets (income, education, occupational status) ignores potential additive or interactive effects such as those captured in measures of multiple deprivation (Fairburn, Maier, & Braubach, 2016). The studies reviewed mainly reported education as only one possible indicator of SES with limited range, as the majority of the studies were conducted in undergraduate student populations. This suggests that better reporting of more SES facets in future studies would allow a more complete picture on the role of SES facets in behavior self-regulation. In addition, the classification system used in this review (Lampert et al., 2013) might be biased and an oversimplification of the relationships of different SES facets, but at the time of writing was the only comprehensive study providing comparisons over different SES facets. In addition, it allowed for more fine-



grained moderator analyses which go beyond the median splits often used in meta-regression. An additional limitation lies in the sample size in the moderation analyses (apart from education). Simulation studies suggest that sufficient power can only be assumed in meta-regressions that include  $k > 40$  studies (López-López, Marín-Martínez, Sánchez-Meca, Van den Noortgate, & Viechtbauer, 2014), which was not the case for the moderator analyses using income. Future studies in this domain could examine in how far indicators of socioeconomic status are related to differential levels and dispersion of social cognitions, thus allowing examination of the sufficiency hypothesis of the TPB in more detail. However, this would also require better reporting of both SES and correlations between SES indices and physical activity in future studies. A further limitation might lie in the focus of the study on studies assessing variables from the TPB. The main rationale for this was to limit heterogeneity due to inconsistent assessment of key variables such as intention, but at the same time this limits our findings (and the studies included) to those using TPB-based operationalizations of key variables. It would further be useful to extend the range of cognitions beyond the TPB which has been seen substantial critical comment, mostly for oversimplification (Head & Noar, 2014; Sniehotta, Penseau, & Araújo-Soares, 2014).

### **Implications**

Notwithstanding these limitations, this systematic review with meta-analysis has some significant implications. This is the first integrative review examining the role of facets of socioeconomic status in the self-regulation of health behavior, in this case, physical activity. It suggests that in particular individuals with lower educational attainment would profit from interventions that facilitate the translation of intentions into physical activity such as e.g., implementation intentions (Bélanger-Gravel, Godin, & Amireault, 2011). The review further points to the notion that current theories of health behavior could be improved by a better and specific integration of the role socioeconomic and potentially socio-structural variables play

in understanding health behavior. It further demonstrates that different indicators of socioeconomic status have different effects on the relation between social cognitions and behavior, which suggests that future studies should be more explicit and careful in measuring and describing the different aspects of socioeconomic status of their sample. The review is limited by the quality of the studies it is based on, but findings suggests that education is a key factor in health behavior self-regulation, and that in particular measures to promote health in disadvantaged populations may need to take this into account.

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Table 1. Mixed model meta-regression of effect sizes on SES indicators

$r_z$ (TPB variable-behavior)	$k$	$N$	Intercept	$B$ (SE)	95% CI	$p$	$Q_E$ (df)	$Q_{Mr}$ (df)	$I^2$	$R^2$
Income										
Intention – behavior	17	3,906	0.36	0.03 (0.04)	-0.06, 0.12	.48	77.99 (15)***	0.52 (1)	77.68%	0.00%
PBC – behavior	19	4,285	0.25	0.02 (0.05)	-0.09, 0.13	.73	159.24 (17)***	0.12 (1)	87.96%	0.00%
Attitude – behavior	19	4,285	0.28	0.01 (0.04)	-0.08, 0.10	.79	102.75 (17)***	0.07 (1)	82.82%	0.00%
Subjective norm – behavior	15	3,684	0.13	0.01 (0.03)	-0.06, 0.08	.77	22.73 (12)*	0.08 (1)	42.05%	0.00%
Education										
Intention – behavior	87	24,867	-0.27	0.16 (0.03)**	0.09, 0.24	<.0001	1059.96 (85)***	20.90 (1)***	92.17%	21.99%
PBC – behavior	85	24,148	0.47	-0.02 (0.04)	-0.11, 0.06	.56	1276.83 (83)***	0.33 (1)	91.16%	0.00%
Attitude – behavior	81	22,744	0.34	-0.01 (0.03)	-0.07, 0.05	.74	576.57 (79)***	0.10 (1)	83.74%	0.00%
Subjective norm – behavior	73	21,404	0.44	-0.06 (0.03)	-0.12, 0.01	.09	479.64 (71)***	2.99 (1)	82.34%	3.43%



*Note.* \*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$ ; PBC – Perceived Behavioral Control.  $Q_E = Q$  statistic for residual between-studies variance,  $Q_M = Q$  statistic for the moderator. No moderator analyses for occupation due to insufficient variation in this moderator.

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Figure 1: PRISMA Flow Chart

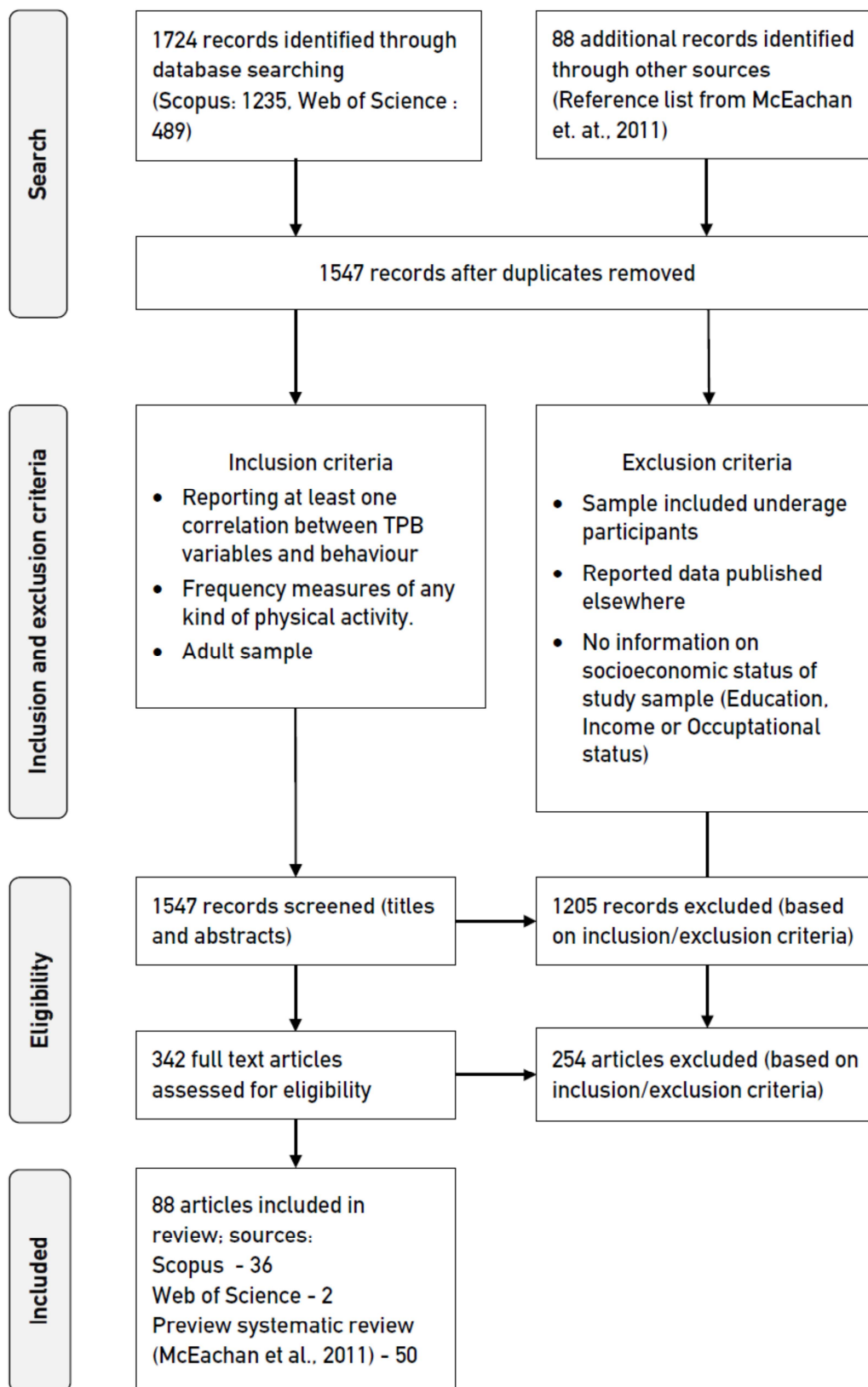
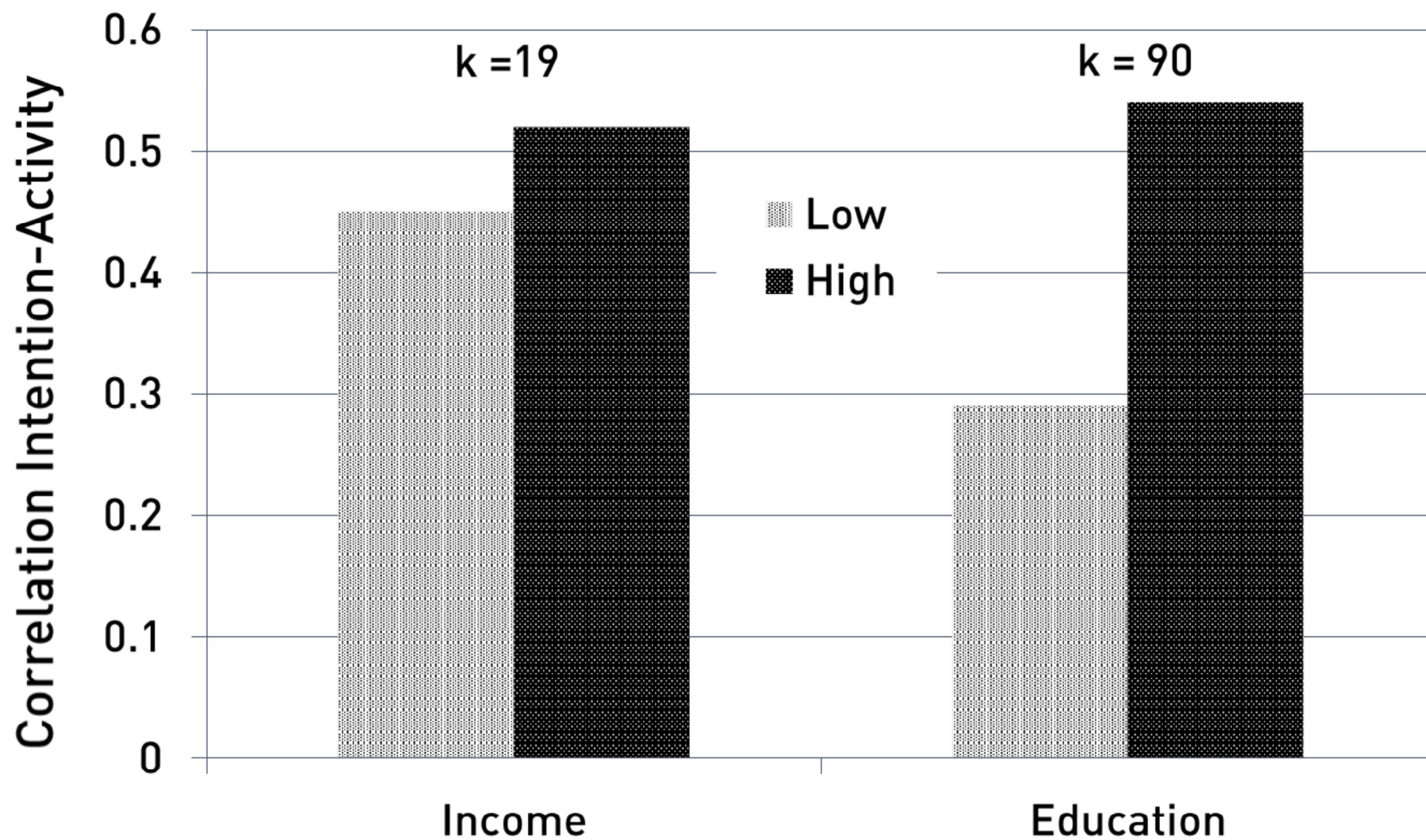


Figure 2: Estimates of the pooled correlation coefficients in samples with high/low income and education



### Highlights

- Socioeconomic status (SES) is underrepresented in psychosocial theories of physical activity
- First systematic review to explore whether SES moderates the effects of social cognitions on activity
- Educational attainment moderates the effects of intention on physical activity