REVIEW

Personality correlates of physical activity: a review and meta-analysis

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Br J Sports Med 2006;**40**:958–965. doi: 10.1136/bjsm.2006.028860

This review aimed to combine the literature on major personality traits and physical activity alongside providing some meta-analytic summaries of the findings. Overall, 33 studies containing 35 independent samples, ranging from 1969 to 2006, met the inclusion criteria. Extraversion ($r = 0.23$), neuroticism ($r = -0.11$) and conscientiousness ($r = 0.20$) were identified as correlates of physical activity using random effects meta-analytic procedures correcting for sampling bias and attenuation of measurement error. The five-factor model traits of openness to experience/intellect and agreeableness, as well as Eysenck's psychoticism trait, were not associated with physical activity. Potential moderators of personality and physical activity relationships such as sex, age, culture/country, design and instrumentation were inconclusive given the small number of studies. Still, the existing evidence was suggestive that personality and physical activity relationships are relatively invariant to these factors. Studies examining personality and different physical activity modes suggested differences by traits such as extraversion, but more research is needed to make any conclusions. Future research using multivariate analyses, personality-channelled physical activity interventions, longitudinal designs and objective physical activity measurement is recommended.

The health benefits of regular moderate physical activity have been well-established,[1] yet participation rates across the population are generally too low to accrue these benefits.[2 3] Thus, promotion of physical activity is a public health priority. Understanding the antecedent correlates of participation in physical activity is considered a useful first-stage endeavour to focus on intervention efforts. This large body of research has provided evidence that physical activity participation is related to many factors, spanning personal, social and environmental categories.[4] A personal factor that has received continued, albeit modest, attention in exercise and health psychology across the years is personality.

Personality trait psychology has a long and tumultuous history,[5 6] but a re-emergence of interest over the past 20 years has resulted in a proliferation of research. Overall, personality itself has numerous definitions, but most encompass the concepts that traits are enduring and consistent individual-level differences in tendencies to show consistent patterns of thoughts, feelings and actions.[7] Many researchers further theorise that personality has a biological or genetic basis.[7–9] The recent interest in personality research stems from improved psychometric instrumentation[9] and growing evidence showing that personality is heritable, structured similarly across cultures, has high temporal (rank order) stability and does not relate strongly to parental rearing style.[7]

One of the other advances in personality trait psychology is the move towards a common higher-order trait taxonomy.[5 10] Common taxonomies range from two to seven basic factors, but the most popular personality model is a five-factor taxonomy. This model suggests that neuroticism (ie, tendency to be emotionally unstable, anxious, self-conscious and vulnerable), extraversion (ie, tendency to be sociable, assertive, energetic, seek excitement and experience positive affect), openness to experience/intellect (ie, tendency to be perceptive, creative, reflective and appreciate fantasy, and aesthetics), agreeableness (ie, tendency to be kind, cooperative, altruistic, trustworthy and generous) and conscientiousness (ie, tendency to be ordered, dutiful, self-disciplined and achievement oriented) are the basic factors of personality structure. The second most popular, and more established, model of personality is Eysenck's[8] three-factor model, which includes similar extraversion and neuroticism traits as the five-factor model and a psychoticism trait (ie, risk taking, impulsiveness, irresponsibility, manipulativeness, sensation seeking, tough-mindedness and pragmatism). Most research on personality and physical activity apply one of these two models.[11]

Although several pathways for how personality interacts with health have been postulated, personality traits are hypothesised to influence physical activity through a health-behaviour model.[12] This model suggests that the principal effect of personality on health-oriented behaviours is through the quality of our health practices. More specifically, personality is hypothesised to affect social cognitions (ie, perceptions, attitudes, norms and self-efficacy) towards a behaviour, which in turn influence the health behaviour itself.[6 11 13]

This study aimed to review the available evidence for a relationship between personality and physical activity. Complementary to the

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Accepted 9 October 2006

Abbreviations: EPI, Eysenck personality inventory; NEO-FFI, Neo-five factor inventory

increase in general personality research in the past 20 years is a growing number of studies focusing on personality and physical activity. At present, this literature has not been combined and systematically appraised despite some position pieces on the topic.[11 14 15] This review provides preliminary meta-analytical information on the relationship between personality and physical activity and present future directions for this research topic.

METHOD

This review, completed in July 2006, includes a total of 36 peer-reviewed studies obtained systematically through database searches, and manual cross-referencing of bibliographies. Three of these studies used redundant samples for other research questions[16–18] and two incorporated two samples within each paper[19 20]; thus, the final review included 33 peer-reviewed studies and 35 independent samples[19–50] (table 1). The databases searched included the following: Web of Science, PubMed, PsycINFO and Medline. Search terms included various combinations of the key words personality, disposition, extraversion, neuroticism, introversion, openness to experience, agreeableness, conscientiousness, Eysenck, Cattell, psychoticism, individual difference, emotional stability, pessimism, optimism, sociability, hardiness, intellect *and* physical activity, exercise, activity, physically active and active living. This initial electronic search technique yielded 10 337 potential articles, although many were duplicates. Articles included in this review are from peer-reviewed scholarly English journals, published from 1969 to the time of review completion (July 2006).

The inclusion criteria extended to studies of adults (≥18 years), which included a measure of physical activity behaviour, and a comprehensive personality model or major trait. Studies that included subtraits or facet traits of personality, such as type A behaviours,[51] sensation seeking[52 53] or activity,[16] were excluded because they might be construct redundant and do not form the basis for understanding comprehensive personality and physical activity.[11 12] Studies that used dependent variables such as physiological markers,[54 55] preferences of physical activity or related factors,[56] stages of change[57] or social cognitive constructs[58 59] rather than physical activity behaviour were excluded because these are less direct indicators of actual physical activity. In addition, included studies measured physical activity as a discrete or continuous variable, comparing groups who were active with those who were inactive. Studies that measured the physical activity of athletes[60] or compared different groups of athletes[61–63] were not included because the baseline does not include the absence of physical activity.

Existing literature has focused on several subtopics and correlates of personality and physical activity. We created subtopics where at least three studies were present that dealt with a given factor. Thus, subtopics in this review included extraversion, neuroticism, agreeableness, openness to experience/intellect, conscientiousness, psychoticism, Cattell's 16 primary factors, sex, age, cultural differences, physical activity mode, study design, and personality and social cognition models. Of the 35 samples in this review, 18 were cross-sectional and 17 were prospective/longitudinal. Included samples used the following personality instruments: 10 used the Eysenck personality inventory (EPI) (or variant), 10 used the Neo-five factor inventory (NEO-FFI), 3 used Cattell's 16 primary factors, 3 used Goldberg's unipolar markers, 2 used the big five inventory, 2 used the Minnesota multihasic inventory and 1 sample each used the Maudsley personality inventory, Karolinska Scale of Personality, 300 adjective list and 25 personality aspects.

Meta-analytical procedures were used where sufficient samples for comparisons and summary were available. Although no minimum number of studies is recommended in meta-analysis, we considered at least eight samples as a general rule of thumb in this review. Topics with less than eight samples were discussed using narrative review and vote-counting procedures. Our meta-analysis procedures were based on random-effects models with correction for sampling error and measurement attenuation using the procedures recommended by Hunter and Schmidt[64] for correlations. Studies with mean differences (ie, effect size d) were converted to r for these analyses.

RESULTS

Neuroticism

Twenty one samples were available to evaluate neuroticism (N) in meta-analysis[19–22 25–27 30–33 35 38–43 46] for a total of 48 049 participants. The summary r was −0.11, with an observed variance of 0.002 and a sampling error of 0. Further, the 95% credibility interval of population r was −0.02 to −0.20. The results suggest that N is a correlate of physical activity with a small effect, but some moderators across studies may be present. One concern in this analysis was the heavy weighting of summary r from two very large samples.[26 32] In cases such as this, Hunter and Schmidt[64] advise that the meta-analysis be performed both with and without the large samples. Thus, without these two samples, the summary r = −0.17; the difference is not substantive (ie, below Cohen's q statistic for a small effect size[65]), nor does it alter the classification of a small effect size, but it does suggest a slightly higher summary statistic. Instrumentation differences may also be a moderator of the results, but too few studies were available to assess this factor. The most common measures of N applied either the EPI[66] (or variant) or theNEO-FFI.[67] Preliminary vote counting suggests that six of nine studies supported a negative relationship between physical activity and N using the EPI, and eight of 11 samples supported this relationship using the NEO-FFI. These results do not suggest a marked difference. Overall, it seems that N is negatively associated with physical activity but the effect is small.

Extraversion

Twenty three samples were available to evaluate extraversion (E) in meta-analysis (total n = 50 721).[19–22 25–28 30–32 34 35 38–44 46] The summary r was 0.23 (95% credibility interval 0.08–0.38), with an observed variance of 0.006 and a sampling error of 0. The results suggest that E is a correlate of physical activity with a small–medium effect, but some moderators across studies may be present. Still, the population standard deviation (SD) of r was only 30% of the summary r; thus the population variance of r is quite small in terms of absolute value. Similar to the analysis of N, we also performed the meta-analysis without two very large studies[26 32] because these are such heavy weights on the results. Without these two samples, the summary r = 0.17. Like N, the difference is not substantive and does not alter the classification of a small effect size, but it does suggest a slightly lower summary statistic. Instrumentation differences did not appear to vary the overall results considerably when comparing the NEO-FFI with the EPI. Six of eight studies using the EPI supported a positive relationship between physical activity and E, and 10 of 11 samples using the NEO-FFI supported this relationship.

Psychoticism

Although psychoticism (P) is a key trait in Eysenck's[8] three-factor model of personality, it has not received as much research attention in the physical activity domain as E and N.

Table 1 Personality and physical activity behaviour

Study	Participants	Design	Personality measure	PA measure	Sig. and ES values
Brunner[49] (1969)	n = 60; male university students, employees and alumni: mean age 38 years	Cross-sectional	300 Adjective checklist (24 factors)	Dichotomous variable: regular vigorous PA, non-regular vigorous PA	Active participants had higher ($p<0.05$) intraception, favourability, defensiveness, achievement, dominance, self-confidence; inactive participants had higher ($p<0.05$) succorance, counselling readiness
Massie[22] (1971)	n = 49; middle-aged business men: aged 29–56 years	28-week prospective	MPI	Attendance to exercise programme	N sig. associated with PA ($d=0.33$; $p<0.05$). E neg associated with PA ($d=0.38$; $p<0.05$)
Renfrow[24] (1979)	n = 46; male faculty members: aged 29–70 years	Cross-sectional	Cattell 16 PF	Dichotomous variable: active, inactive	Following were sig. associated with active < inactive ($p<0.05$) outgoing ($d=0.76$), conscientious ($d=0.93$), shrewd ($d=0.64$). Sig. associated with active > inactive ($d<0.05$): suspicious ($d=0.57$), liberal ($d=1.05$) and self-sufficient ($d=1.00$)
Bolton[23] (1979)	n = 52; young adult female joggers and non-joggers: aged 24–57 years	Cross-sectional	Cattell 16 PF	Dichotomous variable: active, inactive	Active subjects were more stable, less tense and less anxious ($p<0.05$)
Blumenthal[48] (1982)	n = 35; patients with myocardial infarctions (32M, 3F): mage 53.7	1-year longitudinal	MMPI	Dichotomous variable: complier, drop-out	Compliers scored higher on scales L and K and lower on scale F; drop-outs scored sig. higher on scales O and A ($p<0.05$)
Howard[45] (1987)	n = 121; middle-aged managerial and professional males: mean age 44 years	5-year longitudinal	Cattell 16PF	Self-report questionnaire created for the study	Introverts scored higher on ($p<0.10$) gardening and home improvement; extroverts scored higher on ($p<0.10$) fishing, swimming, dancing, aerobic exercise and tennis
Schnurr[50] (1990)	n = 204; male university graduates: mean age 64 years	46-year prospective	25 personality aspects	Self-report questionnaire created for the study	Positive associations with exercise: vital, integrated, political—associations with exercise: unstable autonomic function, sensitive, shy, creative, science interest, cultural interest
Kirkcaldy[21] (1991)	n = 306; mature college and university students (114M, 192F): mean age 26.41 years	Cross-sectional	EPQ	Self-report questionnaire created for the study	E sig. associated with active participants ($d=0.34$; $p<0.05$), N sig. associated with inactive participants ($d=0.21$; $p<0.05$)
Szabo[29] (1992)	n = 35; students (20F, 15M): mage 23.1, 24.2	Cross-sectional	EPI	Dichotomous variable: exercising, non-exercising	Sig. diff. with E ($p<0.01$); non-exercising females scored higher on N than exercising females and males and non-exercising males ($p<0.05$)
Potgieter[25] (1995)	n = 116; student and faculty members (61M, 55F): mean age 21.5 years	12-month prospective	EPI	Dichotomous variable: adherers, drop-outs	More Ns dropped out ($d=0.46$; $p<0.05$). No diff. in groups with E ($d=0.14$)
Yeung[27] (1997)	n = 252; physically active adults (204F, 48M): mean age 33.69 years	Cross-sectional	EPQ-R	PAS: self-report questionnaire	Sig. association with N ($r=-0.23$; $p<0.001$); no association ($p>0.05$) with P ($r=0.02$) and E ($r=0.10$)
Yeung[28] (1997)	n = 46; females: mean age 31.9 years	8-week prospective	EPQ-R	Exercise programme adherence	Sig. association between E and exercise adherence ($r=-0.4$; $p<0.013$)
Siegler[37] (1997)	n = 4426; students (3630M, 796F): mean age btwn 43–45 years	Cross-sectional	MMPI	Self-report questionnaire created for the study	All personality variables sig. values; none reached small ES
Arai[26] (1998)	n = 22448; Japanese adults (8745M, 13703F): mean age 50.4 years	Cross-sectional	EPQ-R	Self-report questionnaire created for the study	N—assoc. ($p<0.05$) with PA ($d=0.22$), P ($d=0.15$) and E ($d=0.43$) and associated with PA
Courneya[35] (1998)	n = 264; undergraduate students (164F, 100M): mean age 21.3 years	Cross-sectional	NEO-FFI	GLTEQ—split into moderate and strenuous exercise	PA was associated with ($p<0.05$) N ($r=-0.12$), E ($r=0.13$), and C ($r=0.18$)
Droomers[47] (1998)	n = 2598; adult males and females: aged 15–74 years	Cross-sectional	EPQ – N only	Self-report questionnaire created for the study	Highly inactive people were 2.2 X more likely to be N
Marks[33] (1999)	n = 97; older adults (29M, 68F): mean age 77 years	Cross-sectional	BFI: measures for C and N	PLQ	Sig. value for C: ($r=0.21$; $p<0.05$) No sig. value for N
Courneya[20] (1999)	$n^1=300$; female university students: mean age 19.6 yearsand $n^2=67$; females in exercise classes: mean age 25 years	n^1 = cross-sectional $n^2=11-$week prospective	NEO-FFI	n^1 = GLTEQ n^2 = attendance to aerobic exercise classes	n^1 = sig. associations for N ($r=-0.13$; $p<0.05$), E ($r=0.28$; $p<0.01$) and C ($r=0.23$; $p<0.01$) n^2 = sig. associations for N ($r=-0.03$; $p<0.05$), E ($r=0.29$; $p<0.01$), and C ($r=0.21$; $p<0.05$)
Sale[46] (2000)	n = 187; young adults (80M, 107F): mean age 24 years	Cross-sectional	EPI	Self-report questionnaire created for the study	E sig. associated with PA ($r=0.19$; $p<0.01$)
Van Loon[34] (2001)	n = 2514; Dutch adults (1083M, 1431F): mean ages 42.6, 41.5 years	Cross-sectional	EPQ	Modified Baecke list—PA split into low, medium and high	Sig. diff. in E with males btwn low and high ($d=0.29$; $p<0.05$)
Rhodes[43] (2001)	n = 175; non-metastatic breast cancer survivors: mean age 52.3 years	Cross-sectional	NEO-FFI	GLTEQ	Sig. association ($p<0.05$) for N ($r=-0.17$) E ($r=0.24$) and C ($r=0.19$)
Conner[39] (2001)	n = 123; university students (104F, 19M): mean age 21.8 years	2-week prospective	BFI+NEO-FFI: C	Self-report questionnaire created for the study	Sig. association with C ($r=0.32$; $p<0.001$)
Bryan[44] (2002)	n = 210; undergraduate students (147F, 63M): mean age 18.59 years	3-month prospective	Goldberg unipolar markers—E only	Self-report questionnaire created for the study	E associated ($p<0.10$) with both aerobic exercise ($r=0.12$) and strength training ($r=0.21$)

Study	Participants	Design	Personality measure	PA measure	Sig. and ES values
Courneya[40] (2002)	n = 51; cancer survivors (43F, 8M): mean age 52.5 years	10-week prospective	NEO-FFI	GLTEQ	Sig. relationship (p<0.05) btwn exercise adherence and N (r = −0.27), E (r = 0.25), and O (r = 0.24).
Rhodes[42] (2002)	n = 301; female undergraduate students: mean age 19.42 years	1-month prospective	NEO-FFI	GLTEQ	Sig. associations (p<0.05) for N (r = −0.16), E (r = 0.25) and C (r = 0.16)
Rhodes[19] (2003)	n^1 = 303; undergraduate students (223F, 80M): mean age 19.99 years n^2 = 272; cancer survivors (190F, 82M): mage 60.7	n^1 = 2-week prospective n^2 = cross-sectional	n^1 and n^2 = NEO-FFI	n^1 and n^2 = GLTEQ	n^1 = Sig. associations (p<0.05) for N(r = −0.19), E (r = 0.24), and C (r = 0.16) n^2 = Sig. association with E (r = 0.14; p<0.05)
Rhodes[41] (2003)	n = 298; university students (212F, 86M): mean age 19.87 years	2-week prospective	Goldberg unipolar markers	GLTEQ	Sig. association (p<0.05) with E (r = 0.34), O (r = 0.21) and C (r = 0.15)
Hausenblas[31] (2004)	n = 390; university students (187F, 203M): mean age 21.8 years	Cross-sectional	NEO-FFI	GLTEQ	Sig. association with E: (r = 0.16; p<0.01)
Kjelsas[36] (2004)	n = 1482; Norwegian university students (905F, 577M): mean ages 23.5, 24.4 years	Cross-sectional	KSP	Self-report, 7-day PA questionnaire	Sig. values for weekly hours of PA (p<0.01): E: (std. β = 0.09) and N: (std. β = 0.21)
Giacobbi[30] (2005)	n = 106; college students (84F, 24M): mean age 20.5 years	8-day prospective collapsed	NEO-FFI	GLTEQ	No sig. values reported; (p>0.05)
Wilson[38] (2005)	n = 6158; seniors (3738F, 2420M): mean age 75 years	6-year longitudinal (PA/personality correlations cross-sectional)	NEO-FFI	Adapted questions from the 1985 Health Interview Survey	Sig. values (p<0.001) for N (r = −0.13) and E (r = 0.09)
De Moor[32] (2006)	n = 19288; Dutch adolescent and adult twins and their families (8773M, 10515F): mean age 33 years	11-year longitudinal	EPQ—Dutch Version	Self-report questionnaire created for the study	Exercisers scored higher on E (d = 0.32). and lower on N (d = 0.14)

A, agreeableness; BFI, Big Five Inventory; btwn, between; C, conscientiousness; d, effect size; diff., difference; E, extraversion; EPI, Eysenck personality inventory; EPQ, Eysenck personality questionnaire; EPQ-R, Eysenck personality questionnaire—revised; F, female; KSP, Karolinska Scale of Personality; M, male; MMPI, Minnesota multiphasic inventory; MPI, Maudsley personality inventory; O, openness to experience; N, neuroticism; NEO-FFI, -five factor inventory; P, psychoticism; PA, physical activity; PAS, physical activity scale; PF, primary factors; PLQ, personal lifestyle questionnaire; sig., significant; std., standard.

Still, this may be largely due to a consistency of null effects. All the five studies to assess this trait report no relationship between P and physical activity.[21 26–28 36] This includes two large sample studies, suggesting that continued work with P and physical activity may be unnecessary.

Openness to experience/intellect

Twelve samples included the openness to experience/intellect (O) factor found in the five-factor model of personality (total n = 2651).[19 20 30 31 35 39–43] This factor is generally named openness to experience,[5] but some theorists who use adjective descriptors to assess personality refer to this factor as intellect.[10] Of these 12 studies in the exercise domain, only two found this trait to be a significant correlate of physical activity.[40 41] More telling, however, was the meta-analytical summary r = 0.08, with an observed variance of 0.01 and a population sampling error of 0.01. Because the system error was negligible after accounting for population sampling error, the presence of moderators across studies is unlikely.

Agreeableness

Eleven samples were available to evaluate the relationship between agreeableness (A) and physical activity (total n = 2600).[19 20 30 31 35 39 41–43] The summary r was 0.01, with a small observed variance and sampling error that resulted in a population variance of 0. This was also similar to traditional vote counting; none of the 11 studies showed a significant (p<0.05) relationship between A and physical activity. Thus, no evidence for this relationship is present.

Conscientiousness

Of the 12 samples available to evaluate a relationship between conscientiousness (C) and physical activity,[19 20 30 31 33 35 39 41–43] nine showed significant positive findings (total n = 2697).[19 20 33 35 39 41–43] The summary statistic was r = 0.20, and the population variance was small after accounting for sampling error (0.005). Still, <50% of the observed variance (0.009) was accounted for by sampling error (0.004), and the 95% credibility interval was r = 0.06 to 0.34, indicating some range in the population r. These findings support a small relationship between C and physical activity, but suggest that some study moderators may be present.

Cattell's 16 primary factors

Cattell[68] was one of the early users of factor analysis in personality trait research. Arguing that traits must be determined empirically, Cattell used the lexical approach of personality trait development by looking at commonalties in descriptors in natural language. Using this approach, Cattell[68] developed the following 16 dimensions as traits that make up a model of personality: cool–warm, concrete–abstract thinking, affected by feelings–emotionally stable, submissive–dominant, sober–enthusiastic, expedient–conscientious, shy–bold, tough–tender minded, trusting–suspicious, practical–imaginative, forthright–shrewd, self-assured–apprehensive, conservative–experimenting, group-oriented–self-sufficient, undisciplined–controlled, relaxed–tense. Further, Cattell[68] also included two second-order factors that encompass these 16 dimensions: extraversion and anxiety/neuroticism.

The 16 primary factors have been used in two cross-sectional[23 24] and one prospective study[45] in the physical activity domain. The small number of studies and different results reported negate a meta-analytical summary. Renfrow and Bolton[24] compared male and female regular exercisers and non-exercisers in cross-sectional studies. Several trait differences emerged. For example, in men, higher scores for non-exercisers (n = 23) were identified in the traits of conscientiousness, outgoing (bold) and shrewdness. By

contrast, exercisers (n = 23) were identified as more suspicious, liberal and self-sufficient than non-exercisers. In women (27 joggers and 25 non-joggers), active subjects were more stable, less tense and less anxious.

Howard *et al*[45] used the 16 primary factors in a 5-year prospective study of middle management executives engaging in a fitness programme to predict physical activities. Although only the E factor is reported in the behavioural data, the results indicated that extraverts performed more exercise than introverts over the fifth year (42% *v* 28%; $p<0.05$). Still, conclusions for associations of the 16 primary factors and physical activity are difficult when summarising these three studies, because of differences in physical activity measures used, personality factors displayed in the results, and methodological issues of design and small sample size.

Sex

Seven studies directly compared personality correlations with physical activity by sex,[26 29 32 34 36 37 46] as well as two complementary sex studies[23 24] and an additional six studies that included either female only[20 28 42 43] or male only[22 45] samples. Unfortunately, information (only one study with full information for males) was too limited to perform meta-analysis procedures. Six studies that included males and females measured Eysenck's E and N factors.[26 29 32 34 36 46] Sex variation for E was mixed, with three studies showing no difference[26 29 32] and three studies indicating a sex difference.[34 36 46] Among the sex-discrepant findings, two studies found E and physical activity relationships to be significant for females but not males,[36 46] whereas the other study found the reverse.[34] Studies using the five-factor model with exclusively female participants have been reliable in this positive E and physical activity correlation.[20 42 43] Extraversion in females may be particularly important to overcome the already discrepant sex difference in physical activity rates.[4] Still, an exclusive male population sample measuring E with Cattell's 16 primary factors showed a positive relationship with vigorous physical activity,[45] and, most important, the two large-scale population assessments of E by sex have indicated no sex differences.[26 32] N has less discrepancy than the findings of E. Specifically, four studies, including the two large-scale population surveys, have identified no sex difference across results,[26 32 34 46] whereas the other two studies showed a negative association between N and physical activity for females but not males.[29 36] Overall, the findings for sex differences in N and E relationships with physical activity are mixed, but sex does not seem to moderate the relationship reliably.

Research on other major personality traits and physical activity by sex is even less conclusive than E and N. Small samples of males and females comparing Cattell's 16 primary factors have shown discrepant findings,[23 24] as has a study using the Minnesota multiphasic inventory.[37] The one study to compare P and physical activity relationships by sex found no significant difference.[26] No studies have compared males and females on the five-factor traits of A, O and C. Of these, however, a comparison of C seems the only noteworthy analysis needed given the null results of A and O. No conclusions can be drawn about sex differences in any of these personality factors, at present, given this limited information.

Age

Only one study covered a sufficiently wide age spectrum to evaluate young, middle-aged, and older adults.[32] No age-related differences were identified for Eysenck's E or N traits despite the age-related decline in physical activity. This is a convincing study, given the size of the sample (n = 19 288) and the repeated-measures 11-year longitudinal design. Unfortunately, inadequate information is present in the remaining studies to include this factor in meta-analysis but some evaluation of major traits can be made on the basis of the age range of studies. The personality and physical activity literature is biased towards young adults: 15 samples were composed of undergraduate students.[19–21 25 29–31 35 36 39 41 42 44 46] Of these, 12 found an association between E and physical activity.[19–21 29 31 35 36 41 42 44 46] Of the 14 samples to assess N, seven found a negative association with physical activity.[19 20 25 35 36 42] Finally, of the eight samples to evaluate C, six found a significant positive association with physical activity.[19 20 35 39 41 42]

Similar findings are apparent in middle-aged and older population samples.[19 22 26 33 34 38 40 43] Of the seven samples that assessed E, six found it positively related to physical activity.[19 26 34 38 40 43] Five of eight studies to measure N found it a negative correlate of physical activity.[22 26 38 40 43] Finally, two of four studies to measure C found a positive association with physical activity.[33 43] Although more population-level research on age, personality and physical activity is needed, the results of existing studies generally suggest that age is not a moderator of the personality–physical activity relationship. This supports the temporal stability inherent in personality research generally[7] and suggests that personality may be a systematic and continual correlate of activity.

Country/culture

Personality is considered to be cross-cultural,[6–8] and thus findings between physical activity and personality traits across cultures should be stable. In our review, data are represented from eight countries. Canada has the most representation,[6 7 19 20 22 29 35 40–43 45] with 12 of the possible 27 samples of common trait taxonomies that could be used for cross-country evaluation. This is followed by the US (n = 5),[30 31 33 38 44] UK (n = 4),[27 28 39 46] The Netherlands (n = 3),[32 34 47] Japan (n = 1),[26] Norway (n = 1),[36] Germany (n = 1)[21] and South Africa (n = 1).[25] Obviously, the small number of studies negates meta-analyses using country as a moderator and limits the cross-cultural conclusions that can be drawn. Still, E and N were measured in all countries. Overall, E was positively related to physical activity in 11 of 12 Canadian samples,[19 20 35 40–43 45] three of four US studies,[31 38 44] one of four UK studies,[46] two of two Netherlands studies,[32 34] and studies from Japan,[26] Germany[21] and Norway.[36] N was negatively associated with physical activity for eight of 11 Canadian samples,[19 20 22 35 40 42 43] one of four US studies,[38] one of four UK studies,[27] two of three studies from The Netherlands,[32 47] as well as studies from South Africa,[25] Japan[26] and Norway.[36] Finally, a positive relationship has been found for C in seven of nine Canadian samples,[19 20 35 40–43] one of three US studies,[33] and in the single UK study to assess this trait.[39] Although we could interpret that certain countries (eg UK *v* Canada) might be different, a more consistent finding in null results may be due to sample size and thus power issues. In general, null results were found in the smaller samples. As effect sizes for personality and physical activity are small, this seems a likely reason for the discrepancies. Still, future analyses by countries with matched sample sizes would be helpful to evaluate the effect of culture on personality and physical activity relationships.

Physical activity mode

Physical activity is often measured as an omnibus construct, but it is in fact comprised of a collection of behaviours. Evaluation of differences in physical activity correlates by modality is sparse; thus it is not surprising that limited research is available for evaluating personality and specific physical activities. Five studies specified a more particular mode or modes of physical activity rather than just mode preferences.[21 35] The most common specific mode was aerobic exercise.[20 25 28 44 45] Overall, E was positively associated with

this activity in three of five possible evaluations, [20 44 45] and N was negatively associated in one of three possible evaluations.[20] An interesting subfactor of aerobic exercise behaviour included whether aerobics class attendance or general aerobic exercise behaviour was used as the dependent variable. When class attendance was used, the results for E were mixed, with one study showing a positive association,[20] one study showing no association,[25] and one study showing a negative association between E and adherence.[28] The results of N and attendance supported a negative association in only one of three possible studies.[20] These are all small-sample studies which may explain the discrepant findings. No definitive conclusions can be drawn at this time. The remaining physical activity modes were not similar across studies. For example, strength training was associated with higher E.[44] The most detailed evaluation of physical activity mode and personality was conducted by Howard *et al*.[45] Using the 16 primary factors to measure E, these researchers found that individuals with high E were more likely to engage in swimming, aerobic conditioning, dancing and tennis. By contrast, individuals with less E were more inclined to engage in gardening and home improvement, whereas no differences were identified for walking, jogging, golf and cycling. The results of these studies are interesting and may have implications during physical activity prescription and intervention tailoring.[11] More work is needed on this topic to reach definitive conclusions.

Study design

Studies ranged from cross-sectional to 46 years prospective. Of the traits that can be compared across several studies, 15 were cross-sectional and 13 were prospective in nature. The reasonable number of samples for N and E allowed meta-analysis comparisons. For N, 11 samples[19–21 26 27 31 33 35 38 43 46] could be used for cross-sectional evaluation (total n = 21 187) and 10[19 20 22 25 30 32 39–42] could be used for prospective designs (total n = 20 704). The results found a summary r of −0.15 (95% credibility −0.03 to −0.27) for the cross-sectional design and a summary r of −0.10 (95% credibility −0.06 to −0.16) for prospective designs, suggesting some difference between designs. Still, this difference is negligible considering effect size comparisons (eg, Cohen's q), overall small effect size classification and credibility intervals of population r.

For E, 11 samples[19–21 26 27 31 34 35 38 43 46] could be used for cross-sectional evaluation (total n = 29 762), and 12[19 20 22 25 28 30 32 39–42 44] could be used for prospective designs (total n = 20 959). The results found a summary r of 0.24 (95% credibility 0.11–0.37) for the cross-sectional design and a summary r of 0.21 (95% credibility 0.08–0.33) for prospective designs, suggesting minimal difference.

For an evaluation of C, four of six cross-sectional samples[20 33 35 43] and five of seven prospective samples[19 20 39 41 42] showed positive associations with physical activity. Thus, it seems that personality and physical activity relationships are robust to static or prospective designs. This complements the general literature on psychological correlates physical activity,[69] and personality theory, where traits are theorised as predominantly stable over time.[7] Still, it should be noted that only two studies with comparable traits to cross-sectional studies used designs of ⩾5 years.[32 45] Although their findings did not differ from static surveys, longitudinal studies evaluating personality and physical activity across the lifespan are needed.

Personality and social cognition models

Personality theorists and social psychologists generally agree that behavioural action is unlikely to arise directly from personality.[6–8 11 13 70] Instead, personality is thought to influence behavioural perceptions, expectations and cognitions. Ten samples have incorporated personality with social cognition models to predict physical activity.[19 20 28 39 40 42 44] Nine of these have applied Ajzen's[13] theory of planned behaviour, a model that has excellent predictive validity in the physical activity domain.[71] Seven of these samples have shown the utility of E when predicting physical activity, even after considering theory of planned behaviour variables,[19 20 40–42] and one study has found this for C.[39] The single study using Bandura's[72] self-efficacy construct also identified E as a unique predictor of physical activity.[28] It has been suggested that personality traits such as E and C may act as good additional predictors of physical activity, because good intentions and other physical activity cognitions can wane as the time for action nears,[11] but this theorising has never been tested. Overall, the results of these studies also suggest that E and C are correlates of physical activity attitudes and perceptions of control/self-efficacy over physical activity. The implications of these relationships suggest that E and C may influence attitudes and a sense of control over engaging in physical activity, which in turn may influence physical activity through intention. Direct tests for mediation in these studies are scarce, however, as they have been primarily aimed at augmenting the predictive validity of the theory of planned behaviour.

Conclusions and future directions

This review was intended to combine the literature on major personality traits and physical activity while providing some preliminary meta-analytical summaries of the findings. Overall, 33 studies containing 35 independent samples, ranging from 1969 to 2006, met our review criteria. E (r = 0.23), N (r = −0.11) and C (r = 0.20) were identified as correlates of physical activity. Five-factor model traits O and A, and Eysenck's P trait were not associated with physical activity. E concerns the differences in preference for social interaction and lively activity;[6 8] the seeking of physical activity behaviours seems a logical extension for people scoring high in this trait, whereas the disinterest in physical activity seems likely for those scoring low in E.[15] Individuals with high N represent those people with less emotional stability and more distress, anxiety and depression than those with lower N. Avoidance of physical activity or cancellation of physical activity plans is a logical extension of this trait. The more general relationship between C and health behaviours has also been established.[73] High scores of C represents a purposeful, self-disciplined individual,[5 6] suggesting that this factor may be important in terms of adherence behaviour. The predisposition to maintain physical activity behaviour appears to be logical for individuals who possess higher C than their counterparts with low C.

Potential moderators of personality and physical activity relationships such as sex, age, culture/country, design and instrumentation were inconclusive given the small number of studies. Still, the existing evidence was suggestive that personality and physical activity relationships are relatively invariant to these factors. Studies examining personality and different physical activity modes have shown differences by traits such as E, but more research is needed to make any conclusions. Finally, multivariate analyses of full personality models with physical activity and the inclusion of personality with social cognition models is limited, but preliminary results suggest that E may be the most important factor associated with physical activity. Most studies using E with social cognition studies also found that it may account for additional independent variance in physical activity.

It is important to note that personality correlates of physical activity, such as N, E and C, are within the small effect size range.[65] Small effect sizes are still important considerations for public health initiatives.[74] Interestingly,

these effect sizes are slightly larger than built environment correlates of physical activity.[75] Thus, ''nature'' and ''nurture'' are perhaps relatively equal correlates of physical activity despite their diametrically opposed foundation in human action. Clearly, intermediary constructs (attitudes, social influences and efficacy appraisals) are correlates with larger overall effect sizes with physical activity than either personality or the environment.[11]

Although this review helps summarise the existing research on personality correlates and physical activity, it also paves the way for future directions. Indeed, research with personality and physical activity has remained fairly basic across the past 30 years, focusing largely on bivariate correlations or univariate analyses of variance. Eysenck *et al*[15] made this same commentary in 1982. Major personality traits are theorised as orthogonal to one another, but study results often suggest otherwise.[76] Thus, multivariate analyses of personality models and physical activity are helpful to delimit trait overlap. Limited analyses have been conducted with full personality models in regression equations. Rhodes and Courneya found E to be the most important predictor of physical activity when applying the five-factor model in two samples,[19] and stepwise analyses have often shown similar findings.[28 36 40] Yet, more multivariate analyses will be helpful in future work.

One of the more interesting applications of personality is its interaction with other constructs and physical activity. Most notable is the effect of C and E as moderators of the physical activity intention–behaviour gap.[17 18 41] Other research showing personality as a moderator of physical activity-affect[30] or physical activity-social cognition[18 77] has also been interesting, as have studies that evaluate preferences for physical activity based on personality.[21 35] Evaluation of personality and physical activity intensity has also been scant, but limited research suggests some differences.[35] These studies all aid in moving towards personality channelled interventions, a research endeavour with advocacy[11 14] but no actual evaluation.

Focusing on finer personality traits, or facet traits, may also hold utility. Although starting out with broad traits and health behaviour is recommended to reduce trait redundancies,[11 12] facet traits may provide a clearer understanding of personality and physical activity relations. For example, E's facet traits of activity[16 19 42] and sensation seeking[32 52 53] have received support as key correlates of physical activity. This suggests that individuals with high E may seek out physical activity as a way to achieve their needs to be excited, lively and adventurous, whereas those with low E may avoid physical activity because of opposite dispositions.

Longitudinal studies across the life span are also needed. These studies would be critical in ascertaining personality development and physical activity, as well as the symmetry and asymmetry of personality and physical activity-related decline with ageing. For example, E tends to decline with age,[7] and whether this matches declines in physical activity has yet to be investigated. Similarly, C has been able to predict longevity and health behaviour from childhood.[78] Its association with physical activity across this life span and mediation via physical activity would add to this interesting finding.

Finally, objective assessment of physical activity will undoubtedly aid in the assessment of personality research. Thus far, most studies on personality and physical activity behaviour have used self-report instrumentation that ranges in validity, and studies using more objective means such as programme attendance have relied on very small sample sizes.

In summary, this review of the major domains of personality and physical activity yielded 33 studies and 35 independent samples from which to draw conclusions. N (−), E (+) and C (+) were reliable correlates of physical activity with small effect sizes, whereas O, A and P were not associated with physical activity. Personality moderators of physical activity mode seem possible, but research is limited. Research is also too limited to draw definitive conclusions about sex, age and culture interactions with personality and physical activity, but preliminary research suggests relative invariance. Future research using multivariate analyses, personality-channelled physical activity interventions, longitudinal designs, and objective physical activity measurement is recommended.

ACKNOWLEDGEMENTS

RER is supported by a scholar award from the Michael Smith Foundation for Health Research, a new investigator award from the Canadian Institutes of Health Research, and with funds from the Social Sciences and Humanities Research Council of Canada and the Human Early Learning Partnership. NEIS is supported by a junior trainee award from the Michael Smith Foundation for Health Research.

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Competing interests: None declared.

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Br J Sports Med 2006 40: 958-965
doi: 10.1136/bjsm.2006.028860