


Relationship of health locus of control with specific health behaviours and global health appraisal: a meta-analysis and effects of moderators

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ABSTRACT

Health locus of control (HLOC) refers to beliefs regarding how one's health is influenced by oneself, others, or fate. This meta-analysis investigated whether three HLOC dimensions (internality/I-HLOC, powerful others/P-HLOC, chance/C-HLOC) were related to both specific health behaviours and global health appraisal, and whether these relationships were moderated by gender and age compositions, individualism, and power distance. Three-level mixed-effects meta-analysis was performed on studies examining the associations of HLOC with specific health behaviour ($k=76$, $N=76,580$, 57% women, $M_{age}=43.75$) and global health appraisal ($k=95$, $N=12,068$, 57% women, $M_{age}=45.44$), respectively. For specific health behaviour, the averaged correlations with the HLOC dimensions were generally weak ($r's=-.07$ to $.10$). However, the links between P-HLOC and exercise were moderated by all four demographic moderators, and gender composition and individualism moderated the association between the HLOC dimensions and diet. For global health appraisal, all of the averaged correlations were statistically significant ($r's=-.16$ to $.21$), except that between P-HLOC and mental quality of life. The results further showed individualism and power distance to moderate the links between the HLOC dimensions and both mental and physical quality of life, and gender composition to moderate those between these dimensions and two indicators of emotional problems (depression and anxiety).

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Health locus of control (HLOC) refers to people's attribution of their own health to personal or environmental factors (e.g., Levenson, 1981; Wallston, Wallston, & DeVellis, 1978). Researchers commonly assess the HLOC construct using three dimensions: internality (I-HLOC), powerful others (P-HLOC), and chance (C-HLOC). Various psychological approaches hold differing views of the benefits of positive health beliefs (i.e., high in I-HLOC, low in P-HLOC and C-HLOC). Cognitive-behavioural theories (e.g., Rotter, 1990; see also Williams & Rhodes, 2016 for a review) postulate that such beliefs motivate health behaviour, which refers to voluntary actions taken to promote health and reduce health risks (Sarafino, 2006). These health goals can be attained by engaging in health-enhancing behaviour (e.g., exercise), mitigating health-compromising behaviour (e.g., smoking), or both. Positive psychology theories (e.g., Carr, 2011), on the other hand, posit that positive health beliefs play a central beneficial role in global health appraisal, which refers to the subjective evaluation of one's

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current mental and physical health status (e.g., physical well-being, emotional problems; Schweizer & Döbrich, 2003).

Need for meta-analysis to resolve empirical inconsistencies

To evaluate the salutary roles of the positive health beliefs proposed by these two theoretical perspectives, researchers have examined the relationship of HLOC with both specific health behaviour and global health appraisal. A review of the literature shows mixed findings for both types of relationship, making it difficult to determine conclusively whether positive health beliefs are beneficial to specific health behaviour, global health appraisal, or both.

These seemingly contrary findings may be reconciled by performing meta-analysis, which involves two major methods (e.g., Borenstein, Hedges, Higgins, & Rothstein, 2009). First, main-effects analysis can generate a precise summary estimate indicating both the magnitude and direction of an aggregate relationship between HLOC and a given health criterion. Second, moderator analysis can provide further insight by revealing whether the aggregate relationship is equally strong and of the same direction across demographic groups or is different amongst the groups. Identification of group variations can enhance practitioners' sensitivity to and effectiveness in working within the parameters of their clients' particular health values and attitudes. Health promotion programmes can also be tailor-made to meet the specific needs of clients with distinct demographic characteristics.

A priori moderators

In order to test for moderating effects, several a priori moderators were identified in light of Ross and Sastry's (1999) theory of objective power and perceived control. This theory extends social learning theory by postulating that a sense of personal control is acquired not only through reinforcement in one's environment, but is also influenced by demographic factors, namely gender, age, and culture. Hence, the present meta-analysis examined four moderating effects: gender composition, age composition, individualism, and power distance.

Gender and age compositions. The theory of objective power and perceived control postulates that individuals hold dissimilar control beliefs owing to distinct role expectations, which vary by gender and age. Gender-role theories posit that agency constitutes one of the core masculinity values, with men socialised to be self-sufficient and achievement-orientated (Bussey & Bandura, 1999). Developmental theories highlight the influential role of autonomy in psychosocial development, with youngsters generally trained to be independent (Guisinger & Blatt, 1994; Labouvie-Vief, 1994). These theories imply that independence is a more crucial life task for men and the young, which may explain why loss of the ability to exercise control is particularly distressing for these demographic groups (Smith, Gallo, Goble, Ngu, & Stark, 1998). In light of such gender and age differences in control belief, which in turn influences well-being, we predict closer links between HLOC and global health appraisal for samples containing more men (vs. women) and younger (vs. older) participants.

In light of social learning theories that put forward behaviour as being influenced by the values attached to its outcome (e.g., Bandura, 1977), we predict that the hypothesised relationships between HLOC and specific health behaviour may differ among demographic groups due to their distinct health values and goals. Although researchers have defined health behaviour as voluntary actions for promoting health and preventing disease (e.g., Sarafino, 2006), people differ in their motives for and the expected consequences of engaging in or reducing a particular type of health behaviour. For instance, some may engage in a health-enhancing behaviour to achieve a health goal (e.g., improving cardiovascular fitness), whereas others do so for reasons unrelated to health (e.g., enjoyment of jogging). As different genders and age groups have diverse perceived health risks and goals (e.g., Kuk & Ardern, 2010; McEwan et al., 2016), we predict stronger associations

between HLOC and specific health behaviour for demographic groups that value health goals more (vs. less), such as older adults who experience greater deteriorations in their physical functioning (e.g., Mayer et al., 1994).

Individualism and power distance. Beliefs about personal control are acquired through social interactions and socialisation at not only the micro (e.g., parents, peers) but also macro (e.g., society, country) levels. Of the various cultural dimensions outlined in Hofstede's (2001) cultural values framework, individualism and power distance are predicted to moderate the link between HLOC and health criteria.

Individualism is particularly relevant to control beliefs, as cultural theories state that countries higher in individualism (e.g., Canada) promote self-reliance and environmental mastery, whereas those lower in individualism (e.g., Japan) value interdependence and harmony with the environment (e.g., Triandis, 1995). These cultural differences have been extended to health-related control beliefs. Specifically, individuals from more (vs. less) individualist countries are more likely to perceive their health as being under their own behavioural control (Wrightson & Wardle, 1997), and theories of personal control suggest that such health control beliefs may incite these individuals to take more proactive actions to maintain healthy (e.g., Rotter, 1990). Hence, we predict stronger positive links between I-HLOC and specific health behaviour in countries higher (vs. lower) in individualism.

Recent culture-moderated meta-analysis has identified an inverse link between perceived internal control and psychological symptoms in countries higher in individualism, with that link less salient in countries lower in individualism (Cheng, Cheung, Chio, & Chan, 2013). These findings imply that individuals from more (vs. less) individualist countries exhibit stronger psychological reactivity to a loss of personal control, and we thus predict closer positive links between I-HLOC and global health appraisal for these individuals.

Power distance is particularly relevant to P-HLOC because this HLOC dimension involves perception of control exerted by authority figures (e.g., Brincks, Feaster, Burns, & Mitrani, 2010). In countries with a higher degree of power distance (e.g., Malaysia), citizens are generally more accepting of a social hierarchy in which some possess more social power than others, but such a hierarchical social structure is largely absent in countries with a lower degree (e.g., Norway; Hofstede, 2001). Although Western theories of personal control generally view control exerted by powerful others as having undesirable consequences (e.g., Rotter, 1990), that view may be less applicable to countries higher in power distance. Accordingly, we predict stronger positive relationships between P-HLOC and health behaviour in higher power distance countries, whose members generally trust and adhere to the health advice or recommendations offered by healthcare professionals (e.g., Gao, Burke, Somkin, & Pasick, 2009; Smith, 1999).

As people in higher power distance countries are more likely to accept that authority figures have legitimate power to influence others' health (Smith, 1999), these people may experience less distress when perceiving their own health decisions being determined by others who are more powerful. Hence, we predict weaker inverse associations between P-HLOC and global health appraisal in higher (vs. lower) power distance countries.

Method

Search strategies

Multiple search strategies were employed for retrieving potentially pertinent reports completed on or before December 31, 2015. The key term 'health locus of control' was initially used in electronic bibliographic database searches via ProQuest. A Web of Science search was then performed to locate reports that referenced the articles identified in the database searches, and the reference sections of these reports were perused to locate more articles. Requests for unpublished materials were sent to relevant listservs, online forums, and scholars who had published articles on the same topic over the past decade.

Eligibility criteria

All of the titles, abstracts, or full-text articles located in the foregoing searches were read and evaluated. Articles were included if they met all of the following eligibility criteria.

- (1) The study presented original data describing a relationship between an HLOC dimension (I-HLOC, P-HLOC, C-HLOC) and at least one relevant health criterion.
- (2) The study assessed the HLOC construct using the Multidimensional Health Locus of Control Scale (Wallston et al., 1978), the most popular HLOC measure by far.
- (3) The majority of participants in the study were at least 18 years of age.
- (4) The study had a minimum sample size of 11 because smaller sample sizes can distort meta-analytic findings (Hunter & Schmidt, 2004).
- (5) The study examined self-ratings of HLOC because subjective experience was the target of investigation.
- (6) Sufficient statistical information for coding or estimating effect sizes was reported in the study or obtained through personal contact if unavailable.

The minimum number of articles examining the relationship between HLOC and a particular health criterion was set at 15 to ensure stability in estimating the averaged effect sizes, heterogeneity variances, and regression coefficients in the meta-analysis. Four health behaviours (exercise, diet, smoking, and alcohol consumption) and four indicators of global health appraisal (mental quality of life [MQOL], physical quality of life [PQOL], depression, and anxiety) met this criterion. On the basis of all these criteria, the literature searches identified 64 eligible reports examining HLOC and specific health behaviour, as well as 80 eligible ones examining HLOC and global health appraisal (see the [appendix](#)).

Coding procedures

Two independent raters coded all of the reports selected. Both were blind to the study purpose and research hypotheses. Multiple-coder triangulation was adopted to enhance data coding reliability (Yin, 2003). Specifically, the two raters first coded 10% of the reports as a trial run and resolved any discrepancies before coding the remainder. For the final coding, the inter-rater reliability coefficients were greater than .86.

Coding of effect sizes. The Pearson product-moment correlation coefficient (r) derived from an HLOC dimension and a relevant criterion measure was recorded if available. If an article did not report r values, we transformed other relevant statistical information (e.g., odds ratio, t -test) into correlation coefficients (Lipsey & Wilson, 2001).

Coding of gender and age compositions. To code gender and age compositions, the raters extracted the percentages of female participants and average ages (or age ranges if average ages were not reported) from the selected articles.

Coding of individualism and power distance. To code the cultural dimensions of individualism and power distance, the raters assigned each independent sample a country score based on Hofstede's (2014) quantitative indices. In culture-moderated meta-analyses, each independent sample should refer only to the majority ethnic group (Van Hemert, 2011). Hence, independent samples in which more than half the participants were from ethnic minority groups (e.g., Asians in a US study) were excluded from the analysis with individualism and power distance as the moderators.

Meta-analytic procedures

Conventional meta-analytic techniques assume that effect sizes are independent, but many of the articles selected for this study reported more than one relevant effect size. Three-level meta-analysis

was thus applied to address this potential problem of dependence using the metaSEM package (Cheung, 2015) and metafor package (Viechtbauer, 2010).

In the main-effects analyses, the parameter estimates and their standard errors (and 95% confidence intervals) were estimated using the maximum-likelihood estimation method. The hypothesis of homogeneity of effect size was tested by Q statistics, and the degree of level-2 and level-3 heterogeneity [$\tau^2_{(2)}$ and $\tau^2_{(3)}$] was quantified by I^2 (Higgins & Thompson, 2002), which was extended to three-level meta-analysis [$I^2_{(2)}$ and $I^2_{(3)}$] (Cheung, 2014, 2015).

In the moderator analyses, three-level mixed-effects meta-analysis was conducted. Both level-2 and level-3 R^2 [$R^2_{(2)}$ and $R^2_{(3)}$] were reported. As R^2 may appear exceptionally large even if it is non-significant when the estimated τ^2 is very small, we report the R^2 value only when the estimated τ^2 is larger than .0001.

Detection of possible confounds

Methodological quality. The potential moderating effects of methodological quality were tested using four indicators (see Cheng, Lau, & Chan, 2014 for details), with each ranging from 0 to 1. First, to evaluate measurement validity, the proportion of validated target questionnaires was calculated based on the criteria recommended by Holmbeck et al. (2008). Second, to code measurement reliability, the proportion of target scales or subscales with Cronbach's alphas greater than .70 was computed (Mitchell & Jolley, 2010). Third, to examine statistical power, 1 point was given if the sample size yielded statistical power greater than .70 at a significance level of .05 (e.g., Kraemer, Gardner, Brooks, & Yesavage, 1998), and 0 points otherwise. If such information was not available, ad hoc power analyses were conducted using G*Power software. Finally, to code sample source, 1 point was assigned if the participants had been recruited from more than one centre or source, and 0 points if a single centre or source was involved. In addition, to check whether studies having one time point and those having more than one time point would yield effect sizes of different magnitudes, 1 point was given to studies that included more than one time point, and 0 points for cross-sectional studies.

Publication bias. The potential confounding effects of publication bias were tested using three commonly adopted methods (Lipsey & Wilson, 2001). First, to detect the file drawer problem, fail-safe numbers were obtained to estimate the number of missing studies that would need to be added to nullify statistically significant results (Rosenthal, 1979). Second, to examine whether studies with statistically stronger findings were more likely to be published, the potential moderating effects of publication status (published vs. unpublished) on the magnitude of the various HLOC-health criterion links were investigated. Finally, to check whether larger-scale studies were more likely to be published, funnel plots were created and examined (Greenhouse & Iyengar, 2009). The null hypothesis of effect size symmetry was evaluated using the tests formulated by Egger, Smith, Schneider, and Minder (1997), with symmetric funnels (i.e., $p > .05$) indicating the absence of this type of publication bias.

Results

Characteristics of meta-analytic data set

HLOC and specific health behaviour. Of the 64 selected articles examining the link between HLOC and specific health behaviour, 48% were published. These articles yielded 76 independent samples with 76,580 adult participants ($M = 1008$, range: 12–16,380). Their average age was 43.75 ($SD = 16.39$, range: 19–76), and 57% were women. The participants came from 14 countries, with Hofstede's individualism scores ranging from 17 (Taiwan) to 91 (United States) and power distance scores ranging from 13 (Israel) to 100 (Malaysia).

HLOC and global health appraisal. Of the 80 selected articles investigating the link between HLOC and global health appraisal, 51% were published. These articles contained 95 independent samples with 12,068 adult participants ($M = 127$, range: 15–1391). The mean age was 45.44 ($SD = 12.99$, range: 19–68) and 57% were women. These participants were from 12 countries, with individualism scores ranging from 20 (mainland China) to 91 (United States) and power distance scores ranging from 31 (Norway) to 80 (mainland China).

Main-effects analyses

The results from the three-level mixed-effects meta-analyses of the relationships of HLOC with specific health behaviour and global health appraisal are presented in [Tables 1](#) and [2](#), respectively.

HLOC and specific health behaviour. As shown in [Table 1](#), stronger I-HLOC orientations were related to greater engagement in the two health-enhancing behaviours ($r = .10$ for exercise and $r = .08$ for diet) but to neither health-compromising behaviour (smoking or alcohol consumption). P-HLOC orientations were unrelated to engagement in any of the specific health behaviours except alcohol consumption ($r = -.05$), whereas stronger C-HLOC orientations were associated with less adoption of a healthy diet ($r = -.07$) and more smoking ($r = .08$). All of the statistically significant averaged correlations were in the expected directions, albeit weak in magnitude.

The Q statistic for all of these correlation coefficients was significant at the .001 level (see [Table 1](#)), suggesting that they were not homogeneous. With regard to the degree of heterogeneity, study level (level-3) explained the most, with the exception of the following that had high degrees of level-2 heterogeneity: (a) the correlation between P-HLOC and diet [$I^2_{(2)} = .98$], (b) the correlation between P-HLOC and smoking [$I^2_{(2)} = .62$], and (c) the correlation between C-HLOC and alcohol consumption [$I^2_{(2)} = .47$]. The level-3 $I^2_{(3)}$ for all of the other correlations ranged from .74 to .97. According to the guidelines proposed by Higgins, Thompson, Deeks, and Altman (2003), these ranges are indicative of moderate to high degrees of heterogeneity, and thus of considerable between-study variability. Moderator analyses were thus needed for this set of studies.

HLOC and global health appraisal. The averaged correlations between the HLOC dimensions and indicators of global health appraisal also took the expected directions (see [Table 2](#)). Specifically, stronger I-HLOC orientations were related to better MQOL and PQOL, as well as to lower depression and anxiety levels (r range: $-.12$ – $.11$), whereas stronger external HLOC orientations (P-HLOC and C-HLOC) were related to poorer MQOL and PQOL as well as higher depression and anxiety levels (r range: $-.16$ – $.21$). All of the averaged correlations were statistically significant at the .05 level, with the exception of the link between P-HLOC and MQOL ($r = -.02$). The statistically significant correlations were weak to moderately strong in magnitude.

The Q statistics were statistically significant at the .001 level for all of the correlations (see [Table 2](#)), and study level (level-3) again accounted for the most heterogeneity, except for the correlation between C-HLOC and anxiety. This correlation displayed strong level-2 heterogeneity [$I^2_{(2)} = .72$], indicating considerable within-study variance. The level-3 $I^2_{(3)}$ for the other correlations ranged from .47 to .78. These ranges are indicative of moderate to strong heterogeneity, and thus of considerable between-study variance. These results also revealed the need to perform moderator analyses for this set of studies.

Moderator analyses

Mixed-effects meta-analysis was conducted to test the effects of the four a priori moderators on the relationships of HLOC with specific health behaviour and global health appraisal, respectively. To facilitate further interpretation of the statistically significant moderating effects, we performed follow-up analyses by calculating the averaged correlations conditioned at the ± 1 standard deviation around the mean of those moderators. [Tables 3](#) and [4](#) summarise the findings of the two sets of moderator analysis.

Table 1. Summary of tests examining the direction and magnitude of the HLOC-specific health behaviour relationships.

	Exercise			Diet			Smoking			Alcohol consumption		
	I-HLOC	P-HLOC	C-HLOC	I-HLOC	P-HLOC	C-HLOC	I-HLOC	P-HLOC	C-HLOC	I-HLOC	P-HLOC	C-HLOC
Main-effects analysis												
Averaged <i>r</i>	.0984	.0446	.0030	.0790	.0174	-.0744	-.0138	.0133	.0793	-.0141	-.0544	.0343
Lower 95% CI	.0587	-.0320	-.0571	.0393	-.0467	-.1268	-.0560	-.0135	.0401	-.0525	-.0956	-.0035
Upper 95% CI	.1381	.1212	.0632	.1188	.0815	-.0221	.0285	.0400	.1186	.0242	-.0132	.0720
<i>k</i>	57	46	49	66	48	53	36	25	28	24	18	19
Tests for Heterogeneity												
<i>Q</i>	217.21	1067.99	342.46	223.79	274.13	191.69	306.80	104.68	606.79	75.04	81.14	108.09
<i>df</i>	56	45	48	65	47	52	35	24	27	23	17	18
<i>p</i>	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001
$\tau_{(2)}^2$	N/A	.0000	.0027	.0009	.0402	.0006	N/A	.0014	N/A	.0005	.0002	.0017
$\tau_{(3)}^2$	.0133	.0488	.0275	.0086	N/A	.0147	.0091	.0002	.0054	.0033	.0032	.0014
$I_{(2)}^2$	.0000	.0000	.0835	.0839	.9768	.0374	.0000	.6185	.0000	.1099	.0521	.4716
$I_{(3)}^2$	.8845	.9702	.8657	.8099	.0000	.9018	.9155	.0823	.8902	.7414	.8154	.3780

Notes: C = chance dimension; CI = confidence interval; HLOC = health locus of control; I = internality dimension; $I_{(2)}^2$ and $I_{(3)}^2$: percentage of between-study variation to total variation due to level 2 (multiple measures) and level 3 (studies), respectively; *k*: number of effect sizes; N/A = not applicable (cannot be computed or analysed); P = powerful others dimension; $\tau_{(2)}^2$ and $\tau_{(3)}^2$: between-studies heterogeneity variance due to level 2 (multiple measures) and level 3 (studies), respectively.

Table 2. Summary of tests examining the direction and magnitude of the HLOC-global health appraisal relationships.

	MQOL			PQOL			Depression			Anxiety		
	I-HLOC	P-HLOC	C-HLOC	I-HLOC	P-HLOC	C-HLOC	I-HLOC	P-HLOC	C-HLOC	I-HLOC	P-HLOC	C-HLOC
Main-effects analysis												
Averaged <i>r</i>	.1087	-.0152	-.1643	.1079	-.0838	-.1354	-.1207	.0790	.2146	-.0730	.1164	.1600
Lower 95% CI	.0349	-.0811	-.2449	.0311	-.1400	-.2036	-.1700	.0265	.1729	-.1331	.0575	.1082
Upper 95% CI	.1826	.0507	-.0838	.1847	-.0277	-.0671	-.0714	.1315	.2563	-.0128	.1752	.2118
<i>k</i>	40	41	29	52	45	45	54	47	47	39	36	34
Tests for heterogeneity												
<i>Q</i>	120.55	72.44	67.47	185.66	91.94	123.14	153.51	141.25	115.67	159.74	133.75	106.71
<i>df</i>	39	40	28	51	44	44	53	46	46	38	35	33
<i>p</i>	<.001	.0013	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001
$\tau_{(2)}^2$	.0004	.0000	.0000	.0004	.0014	.0019	N/A	N/A	N/A	N/A	.0003	.0145
$\tau_{(3)}^2$	.0217	.0148	.0182	.0246	.0084	.0144	.0186	.0190	.0082	.0229	.0191	N/A
$I_{(2)}^2$	.0116	.0000	.0000	.0112	.0774	.0767	.0000	.0000	.0000	.0000	.0116	.7153
$I_{(3)}^2$	.6900	.5900	.6773	.7302	.4669	.5915	.6730	.6941	.4994	.7829	.7481	.0000

Notes: C = chance dimension; CI = confidence interval; HLOC = health locus of control; I = internality dimension; $I_{(2)}^2$ and $I_{(3)}^2$: percentage of between-study variation to total variation due to level 2 (multiple measures) and level 3 (studies), respectively; *k*: number of effect sizes; N/A = not applicable (cannot be computed or analysed); MQOL = mental quality of life; P = powerful others dimension; PQOL = physical quality of life; $\tau_{(2)}^2$ and $\tau_{(3)}^2$: between-studies heterogeneity variance due to level 2 (multiple measures) and level 3 (studies), respectively.

Table 3. Summary of moderator analyses for the HLOC-specific health behaviour relationships.

	Exercise			Diet			Smoking			Alcohol consumption		
	I-HLOC	P-HLOC	C-HLOC	I-HLOC	P-HLOC	C-HLOC	I-HLOC	P-HLOC	C-HLOC	I-HLOC	P-HLOC	C-HLOC
Moderator: gender composition (proportion of female participants)												
<i>b</i>	0.1409	0.4427	0.2377	0.1631	-0.0903	-0.2053	0.0992	0.0770	-0.0170	-0.0298	N/A	-0.0186
<i>SE</i>	0.1059	0.2063	0.1680	0.0820	0.1215	0.1025	0.0848	0.0940	0.1252	0.0243	N/A	0.0478
<i>p</i>	.1835	.0318	.1571	.0465	.4571	.0451	.2419	.4125	.8923	.2194	N/A	.6974
$R^2_{(2)}$	N/A	N/A	.0000	.0161	.0121	.0000	N/A	.0000	N/A	.4330	N/A	.0000
$R^2_{(3)}$	.0553	.1558	.0857	.1889	N/A	.2182	.0968	.1647	.0024	.0000	N/A	N/A
<i>k</i>	55	44	47	63	45	50	35	24	27	23	N/A	18
Moderator: age composition (mean age of participants)												
<i>b</i>	-0.0009	0.0065	0.0038	-0.0004	-0.0003	0.0012	0.0036	N/A	0.0010	N/A	N/A	N/A
<i>SE</i>	0.0014	0.0024	0.0020	0.0011	0.0019	0.0018	0.0024	N/A	0.0023	N/A	N/A	N/A
<i>p</i>	.5059	.0068	.0624	.6874	.8650	.4896	.1316	N/A	.6778	N/A	N/A	N/A
$R^2_{(2)}$	N/A	N/A	.0000	.0049	.0008	.0000	N/A	N/A	N/A	N/A	N/A	N/A
$R^2_{(3)}$	.0153	.2181	.1180	.0000	N/A	.0086	.0000	N/A	.0000	N/A	N/A	N/A
<i>k</i>	48	41	43	52	43	44	23	N/A	18	N/A	N/A	N/A
Moderator: individualism												
<i>b</i>	-0.0009	-0.0031	-0.0003	-0.0016	-0.0012	0.0000	N/A	0.0004	0.0017	0.0011	N/A	0.0007
<i>SE</i>	0.0010	0.0015	0.0010	0.0008	0.0017	0.0013	N/A	0.0008	0.0011	0.0008	N/A	0.0008
<i>p</i>	.3519	.0349	.7461	.0483	.4911	.9968	N/A	.6022	.1348	.1837	N/A	.3512
$R^2_{(2)}$	N/A	N/A	.0000	.0000	.0104	.0008	N/A	.0000	N/A	.0281	N/A	.0000
$R^2_{(3)}$	.0123	.1128	.0000	.1722	N/A	.0000	N/A	.9242	.1679	.2421	N/A	N/A
<i>k</i>	52	42	45	57	41	46	N/A	24	27	23	N/A	18
Moderator: Power Distance												
<i>b</i>	0.0001	0.0058	0.0015	0.0008	0.0052	0.0022	-0.0025	N/A	-0.0048	-0.0015	N/A	0.0000
<i>SE</i>	0.0013	0.0017	0.0011	0.0012	0.0027	0.0018	0.0011	N/A	0.0027	0.0011	N/A	0.0010
<i>p</i>	.9199	.0009	.1875	.5148	.0514	.2099	.0261	N/A	.0743	.1481	N/A	.9745
$R^2_{(2)}$	N/A	N/A	.0056	.0000	.1055	.1279	N/A	N/A	N/A	.0268	N/A	.0000
$R^2_{(3)}$	.0000	.2922	.1135	.0106	N/A	.0000	.2368	N/A	.2315	.2645	N/A	N/A
<i>k</i>	52	42	45	57	41	46	35	N/A	27	23	N/A	18

Notes: C = chance dimension; HLOC = health locus of control; I = internality dimension; *k*: number of effect sizes; N/A = not applicable (cannot be computed or analysed); P = powerful others dimension; $R^2_{(2)}$ and $R^2_{(3)}$: explained variances on the level 2 (multiple measures) and level 3 (studies) heterogeneity variances, respectively.

Table 4. Summary of moderator analyses for the HLOC-global health appraisal links.

	MQOL			PQOL			Depression			Anxiety		
	I-HLOC	P-HLOC	C-HLOC	I-HLOC	P-HLOC	C-HLOC	I-HLOC	P-HLOC	C-HLOC	I-HLOC	P-HLOC	C-HLOC
Moderator: gender composition (proportion of female participants)												
<i>b</i>	0.0205	0.1255	0.2281	0.0709	0.0689	−0.1095	0.1424	−0.0115	−0.0447	0.2310	−0.0426	−0.1207
<i>SE</i>	0.1487	0.1110	0.1906	0.1382	0.1132	0.1516	0.0722	0.0794	0.0652	0.0901	0.0950	0.0774
<i>p</i>	.8904	.2583	.2314	.6082	.5428	.4701	.0485	.8848	.4928	.0103	.6542	.1191
$R^2_{(2)}$	.0000	N/A	N/A	.0000	.0674	.0162	N/A	N/A	N/A	N/A	N/A	.0717
$R^2_{(3)}$	.0052	.0565	.0898	.0236	.0000	.0291	.1476	.0000	.0323	.2209	.0000	N/A
<i>k</i>	40	41	29	52	45	45	54	47	47	38	36	34
Moderator: age composition (mean age of participants)												
<i>b</i>	0.0052	−0.0002	0.0005	0.0052	−0.0016	0.0040	−0.0021	−0.0023	−0.0009	−0.0025	−0.0035	−0.0019
<i>SE</i>	0.0027	0.0024	0.0030	0.0029	0.0018	0.0026	0.0023	0.0025	0.0019	0.0021	0.0020	0.0018
<i>p</i>	.0561	.9309	.8666	.0749	.3679	.1155	.3412	.3552	.6231	.2472	.0790	.3066
$R^2_{(2)}$	.0000	N/A	N/A	.0000	.0000	.0587	N/A	N/A	N/A	N/A	N/A	.0445
$R^2_{(3)}$	.2565	.0024	.0088	.1904	.2461	.1130	.0543	.0253	.0000	.0593	.0783	N/A
<i>k</i>	38	31	27	50	43	43	50	43	43	35	32	30
Moderator: individualism												
<i>b</i>	0.0044	−0.0003	0.0025	0.0030	0.0004	0.0028	0.0027	−0.0007	−0.0009	−0.0019	0.0005	0.0000
<i>SE</i>	0.0012	0.0012	0.0015	0.0015	0.0012	0.0013	0.0017	0.0020	0.0016	0.0012	0.0012	0.0010
<i>p</i>	.0002	.7980	.0978	.0488	.7564	.0340	.1165	.7249	.5871	.1095	.6894	.9701
$R^2_{(2)}$	.0000	N/A	N/A	.0000	.0509	.0546	N/A	N/A	N/A	N/A	N/A	.0000
$R^2_{(3)}$	.6190	.0131	.2925	.2668	.0000	.2839	.0843	.0000	.0000	.1128	.0144	N/A
<i>k</i>	39	40	28	51	43	42	46	37	37	38	33	31
Moderator: power distance												
<i>b</i>	−0.0055	−0.0004	−0.0039	−0.0026	0.0002	−0.0018	−0.0059	−0.0038	0.0012	0.0042	−0.0019	0.0000
<i>SE</i>	0.0019	0.0019	0.0022	0.0024	0.0017	0.0021	0.0035	0.0040	0.0034	0.0022	0.0022	0.0018
<i>p</i>	.0043	.8104	.0756	.2807	.9102	.3814	.0871	.3481	.7192	.0523	.3927	.9853
$R^2_{(2)}$	.0000	N/A	N/A	.0000	.0000	.0000	N/A	N/A	N/A	N/A	N/A	.0000
$R^2_{(3)}$	.4440	.0000	.2462	.1148	.0173	.0784	.0834	.0000	.0001	.1629	.0502	N/A
<i>k</i>	39	40	28	51	43	42	46	37	37	38	33	31

Notes: C = chance dimension; HLOC = health locus of control; I = internality dimension; *k*: number of effect sizes; MQOL = mental quality of life; N/A = not applicable (cannot be computed or analysed); P = powerful others dimension; PQOL = physical quality of life; $R^2_{(2)}$ and $R^2_{(3)}$: explained variances on the level 2 (multiple measures) and level 3 (studies) heterogeneity variances, respectively.

HLOC and specific health behaviour. The relationship between P-HLOC and exercise was found to be moderated by all four a priori moderators (p 's < .04). Their $R^2_{(3)}$ values ranged from .11 to .29. Although the overall correlation between P-HLOC and exercise was not statistically significant ($r = .04$), their correlation was statistically significant for samples with a greater proportion of women ($r = .15$) but not for those with a smaller such proportion ($r = -.03$). Similarly, this averaged correlation was statistically significant for samples with higher mean age ($r = .18$) rather than for those with lower mean age ($r = -.04$). In addition, a trend of an inverse relationship between P-HLOC and exercise was observed in samples from countries higher in individualism ($r = -.05$) but a positive such relationship in those from countries lower in individualism ($r = .08$), although neither relationship was statistically significant (p 's = .22 and .07). Finally, as expected, this averaged correlation was positive for samples from countries with higher degrees of power distance ($r = .10$) but negative for those from countries with lower degrees of power distance ($r = -.08$).

For diet, statistically significant moderating effects were found for both gender composition and individualism. Gender composition moderated the correlation between I-HLOC and diet as well as that between C-HLOC and diet ($R^2_{(3)} = .19$ and .22). Amongst the studies examining I-HLOC and diet, the averaged positive association was relatively stronger for the samples containing more (vs. fewer) women ($r = .13$ vs. .04). Similarly, the averaged inverse association between C-HLOC and diet was statistically significant only for those samples with a larger percentage of women ($r = -.12$) but not for those having a smaller such percentage ($r = -.01$). In addition, individualism moderated the averaged correlation between I-HLOC and diet ($R^2_{(3)} = .17$). This correlation was relatively stronger in the samples from countries with lower (vs. higher) levels of individualism ($r = .11$ vs. .04).

Compared with the two health-enhancing behaviours, the moderating effects identified for the two health-compromising behaviours were generally non-significant, with the exception of the statistically significant moderating effect of power distance on the averaged correlation between I-HLOC and smoking. Power distance accounted for 24% of the variance in that correlation. The averaged association between I-HLOC and smoking was statistically significant only for samples from higher power distance countries ($r = -.05$) but not for those from countries lower in this cultural dimension ($r = .03$).

HLOC and global health appraisal. For the two quality of life indicators, statistically significant moderating effects were found only for the two cultural dimensions. For individualism, statistically significant moderating effects were obtained for the links between I-HLOC and MQOL, I-HLOC and PQOL, as well as C-HLOC and PQOL ($R^2_{(3)}$ range: .27–.62). The positive links of I-HLOC with both MQOL and PQOL were relatively stronger in the samples from more (r 's = .22 and .18) vs. less (r 's = .01 and .03) individualist countries, whereas the inverse link between C-HLOC and PQOL was statistically significant for the samples from less ($r = -.19$) rather than more ($r = -.05$) individualist countries.

Power distance was found to significantly moderate the link between I-HLOC and MQOL, accounting for 44% of the variance therein. The positive association between the two was relatively stronger in samples from countries with lower (vs. higher) degrees of power distance ($r = .20$ vs. .02).

For depression and anxiety, statistically significant moderating effects were found only for gender composition and only for their relationships with I-HLOC, with gender composition explaining 15% and 22% of the variance in the I-HLOC-depression and I-HLOC-anxiety links, respectively. The averaged relationship between I-HLOC and depression was relatively stronger for samples with a smaller (vs. larger) proportion of women ($r = -.17$ vs. $-.07$), and that between I-HLOC and anxiety was statistically significant only for those with fewer women ($r = -.15$) but not for those with more women ($r = .001$).

Tests for possible confounds

Methodological quality. Additional moderator analyses were performed to evaluate whether the findings were confounded by the methodological quality of the selected studies. For studies with specific health behaviour as a criterion, the results revealed statistically non-significant moderating effects of

methodological quality (b 's ranging from .00 to .06 in absolute value, p 's > .05), except for the relationships between I-HLOC and exercise ($b = .11$, $SE = .05$, $p = .03$), C-HLOC and exercise ($b = -.09$, $SE = .04$, $p = .03$), I-HLOC and diet ($b = .06$, $SE = .03$, $p = .03$), and C-HLOC and alcohol consumption ($b = .19$, $SE = .07$, $p = .01$). The follow-up analyses show that the relationships between C-HLOC and exercise were relatively stronger in studies with weaker (vs. stronger) statistical power and those with more (vs. less) validated measures, the association between I-HLOC and diet was relatively stronger in studies that recruited participants from more than one (vs. a single) source. Moreover, the link between I-HLOC and exercise and that between C-HLOC and alcohol consumption were relatively stronger in studies including more than one (vs. a single) time point.

For studies with global health appraisal as a criterion, the results showed the moderating effects of methodological quality to be statistically non-significant (b 's ranging from .00 to .08 in absolute value, p 's > .05), except for the relationship between I-HLOC and MQOL ($b = .12$, $SE = .05$, $p = .01$). Follow-up analyses revealed this link to be stronger for samples recruited from more than one (vs. a single) source.

Publication bias. To address the file drawer problem, multiple search strategies were employed in an attempt to locate more unpublished work, with a large proportion (52% for specific health behaviour and 49% for global health appraisal) of such work found. Moreover, all of the fail-safe numbers exceeded Rosenthal's suggested criterion (i.e., $5k + 10$), indicating that the file drawer problem was not a concern.

To determine whether studies with statistically strong findings were more likely to be published, an additional moderator analysis was conducted. Results revealed no statistically significant differences in the magnitude of correlations between published and unpublished articles examining HLOC and specific health behaviour (b 's ranging from .00 to .12 in absolute value, p 's > .05), with the exception of those reporting correlations between I-HLOC and diet ($b = .08$, $SE = .04$, $p = .04$) as well as C-HLOC and alcohol consumption ($b = -.07$, $SE = .03$, $p = .04$). Published (vs. unpublished) articles tended to yield relatively stronger associations between I-HLOC and diet ($r = .11$ vs. $.03$). For those between C-HLOC and alcohol consumption, in contrast, the averaged correlations were statistically significant only for unpublished articles ($r = .08$) but were non-significant for published articles ($r = .01$). No such statistically significant moderating effects were found for the relationships between any of the HLOC dimensions and the four indicators of global health appraisal (b 's ranging from .01 to .07 in absolute value, p 's > .29).

To evaluate whether larger-scale studies were more likely to be published, the Egger tests showed that the overall distributions in all of the funnel plots were roughly symmetrical, with the exception of the correlations of I-HLOC with diet as well as those of C-HLOC with diet, alcohol consumption, or PQOL (p 's < .04), indicating a general absence of this type of publication bias. Taken together, these analyses show no overall confounding effects of methodological quality and selective publication.

Discussion

Merging nearly four decades of HLOC studies, this meta-analysis reveals diverse findings for two major health criteria: global health appraisal and specific health behaviour. With regard to the former, the overall results are largely consistent with positive psychology theories, revealing the beneficial role of positive health beliefs on perceived health status. With regard to the latter, however, the three HLOC dimensions are found to have generally weak or modest relationships with specific health behaviour, and this result is in line with Wallston's (1992) proposition that HLOC is a stronger predictor of general rather than specific health criteria. As generalised expectancy beliefs constitute the core of the HLOC construct, obscure relationships are likely to prevail when general HLOC measures are used to study specific health behaviours (Norman, 1995).

Although the overall effect sizes between HLOC and various health behaviours are small, they are still psychologically meaningful (Cortina & Landis, 2009). To illustrate, the present meta-analysis

reveals considerable differences in the magnitude of the relationship between P-HLOC and exercise among diverse demographic groups. Existing theories of personal control generally predict an adverse impact of P-HLOC on the engagement of health-enhancing behaviour (e.g., Rotter, 1990), but interestingly, this meta-analysis has identified opposite positive associations between this HLOC dimension and exercise in some demographic groups (i.e., predominantly women, relatively old, and from countries with a higher degree of power distance). These results imply that perceiving one's health as being influenced by powerful others may encourage the performance of this health-enhancing behaviour amongst individuals who tend to be more tolerant or accepting of external control (Bussey & Bandura, 1999). Such comparisons reflect that the exertion of health control by people having more power may be interpreted by some demographic groups as desirable and motivational, whereas others may think differently.

It is important to note that such moderating effects are highly domain-specific, and applicable to some health behaviours but not to others. For example, the present meta-analysis indicates that the P-HLOC dimension plays an important role in the exercise domain, but the role of I-HLOC dimension is more influential in the diet domain. Although a sense of personal control is generally more valued by men and members of individualist countries, our findings show relatively stronger positive associations between I-HLOC and diet for samples containing more women or members of less individualist countries.

These surprising findings may be attributable to individual differences in food perceptions and preferences. Specifically, women tend to hold more negative attitudes towards snacks and ready meals, whereas men tend to care less about the nutritional value of such food and enjoy it more (Labrecque, Dufour, & Charlebois, 2011). In addition, women (vs. men) tend to make healthier dietary choices by regulating the quantity and quality of the food they consume (Darviri et al., 2014). Such gender differences in food perceptions and dietary choices may explain the stronger positive relationships between I-HLOC and diet amongst samples containing more women, who tend to express stronger health concerns in their food choices than men (Steptoe, Pollard, & Wardle, 1995).

Cultural differences in food perceptions and preferences have also been found. Cultural theories postulate that individuals from collectivist societies tend to take better care of themselves and to place lower values on leading a hedonic life relative to those from individualist societies (Triandis, 1995), implying an inverse link between individualism and health consciousness. At the country level, prior findings support this theoretical notion, revealing health concerns to be ranked among the top motives for food choices amongst the members of various collectivist countries (e.g., Prescott, Young, O'Neill, Yau, & Stevens, 2002; Wang, De Steur, Gellynck, & Verbeke, 2015). At the individual level, there is also corroborative evidence documenting that compared to individuals characterised by an individualist orientation, those characterised by a collectivist orientation are more prone to eat a healthy diet, pay attention to the nutritional content of food, and avoid unhealthy meals (Dutta-Bergman & Wells, 2002). In light of social learning theory, which postulates that outcome expectancy and values foster behavioural engagement (Bandura, 1977), the meta-analytic findings presented herein indicate that stronger relationships between HLOC and dietary behaviour are more likely found in demographic groups that attach stronger health values to food consumption. Hence, the strength of those relationships tends to vary more as a function of specific health values than demographic characteristics per se.

Theoretical, research, and practical implications

The complex links between health control beliefs and specific health behaviours vary considerably among individuals, highlighting the need to develop a multilevel theory that explicates individual differences in the strength of these links. More specifically, we advocate the formulation of a multilevel framework in which such differences are explicated by the interplay of a variety of moderators at various levels, ranging from the individual or ontogenetic level (e.g., gender, age) to more macro levels (e.g., societal norms, cultural values). Our proposed multilevel approach broadens the scope

of the widely adopted cognitive-behavioural approaches by encompassing both the personal and environmental perspectives with the ultimate aim of enhancing the explanatory and predictive power of the relationships between HLOC and health criteria.

In addition to its theoretical contributions, this meta-analytic study may also inform future research by alerting scholars to the importance of sample heterogeneity when studying the complex relationship between HLOC and health behaviour domains. The majority of studies in this arena test their hypotheses in relatively homogeneous samples (e.g., students from a particular cultural region, patients from a single clinic), and the generalisability of their findings is thus open to question. Future research is encouraged to examine health control beliefs and specific health behaviours in samples with assorted demographic characteristics that allow the examination of various moderating effects, preferably using population-based, cross-cultural, or multinational surveys. Moreover, multilevel modelling should be adopted to ensure the adequate testing of data derived from more heterogeneous samples (Snijders & Bosker, 1999).

Our meta-analytic findings also reveal HLOC to have weak links with various specific health behaviours, implying that a general measure of HLOC may be inadequate for studying specific domains of health behaviour. Measures assessing behaviour-specific control beliefs may offer a better alternative (Norman, 1995), although few such measures are currently available (e.g., Goldman, Greenbaum, & Darkes, 1997; Pastor et al., 2015). Further, owing to their highly behaviour-specific content, the few existing measures may be inappropriate for assessing other domains of health behaviour. This instrument deficiency may partially explain why most studies still adopt general HLOC measures to investigate the relationship between health control beliefs and specific health behaviours despite the importance of assessing behaviour-specific control beliefs having been recognised for decades (Norman, 1995). More effort is thus needed to develop and use tailor-made measures for assessing the role of specific health control beliefs in health behaviours.

The present meta-analytic findings can be further translated into practice by providing insights for healthcare professionals on designing health promotion programmes, training their facilitators, and evaluating programme efficacy. In light of the match-mismatch principle in health communications (Williams-Piehot, Pizarro, Schneider, Mowad, & Salovey, 2005; Williams-Piehot, Schneider, Pizarro, Mowad, & Salovey, 2004), health promotion programmes are likely to be more effective if they match clients' demographic characteristics given their distinct health control beliefs. For instance, our results imply that instructions and schedules prescribed by experts should be emphasised in fitness and exercise programmes designed for older adults, whereas expert directives should be given less weight if the programme participants are youngsters. In addition, given the diverse findings across domains of health behaviour, practitioners should be advised that programmes designed to promote a particular domain (e.g., engagement in regular exercise; McEwan et al., 2016) may not necessarily be effective for promoting health behaviour in other domains (e.g., adoption of a healthy diet; Prestwich et al., 2014). In summary, healthcare professionals need to be sensitive to the demographic characteristics of their target audience and tailor the content of health promotion programmes to that audience's specific health control beliefs.

Cautionary notes and future research directions

This paper reports the results of three-level mixed-effects meta-analysis, revealing several significant moderating effects on the relationships between HLOC and two major health criteria. These moderating effects were found at both the individual (e.g., gender composition) and the country (e.g., individualism) levels, thus highlighting the value of studying HLOC at multiple levels. For instance, although the cultural dimensions of individualism and power distance are found to moderate the relationships between HLOC and some health behaviours, it is important to note that these cultural findings may not be equally applicable to all members of a particular country.

Cultural self-construal theory posits that there are vast individual differences in cultural self-construal within a given society (Markus & Kitayama, 1999), with some individuals characterised by a more

individualist orientation while others by a more collectivist orientation regardless of the orientation of the country as a whole (Cheng et al., 2011). It is thus essential to study moderating effects at both the individual and country levels. Recent multinational comparisons show that some psychological dimensions studied at the individual and aggregate (country) levels yield a distinct pattern of findings (Cheng, Cheung, & Montasem, 2016). We thus recommend the incorporation of multilevel modelling to enrich scholarly understanding of the relationship between HLOC and health criteria across cultures.

It is also noteworthy that our results pertaining to the I-HLOC and C-HLOC dimensions are largely consistent with theoretical postulations, although such supporting evidence is scarcer for the P-HLOC dimension. The results thus provide support for Levenson's (1981) tripartite conceptualisation, which proposes that influences exerted by other people and supernatural forces should be distinguished within the external control domain. Although influence exerted by powerful others may imply a loss of personal control, our findings, such as those pertaining to the exercise domain, indicate that such external influence is undesirable for some but beneficial for others, thus resulting in an overall weak association between health control by powerful others and this health-enhancing behaviour.

According to Walker's (2001) unifying theory of control, interpersonal influences are not always debilitating, but can constitute a form of social support. Consistent with this postulation, Myers and Myers (1999) found that control by physicians explained a substantial portion (35%) of the variance in treatment adherence amongst patients with cystic fibrosis. In addition, some researchers have posited that control by health professionals and control by non-health professionals represent relatively independent dimensions (e.g., Billington, Simpson, Unwin, Bray, & Giles, 2008; McQuillen, Licht, & Licht, 2003), but only a few studies have used separate subscales to assess these two sources of interpersonal control (e.g., Billington et al., 2008; De las Cuevas, Peñate, & Sanz, 2014). Further effort should be made to distinguish the benefits and costs of these sources of interpersonal control after more studies have been conducted.

Finally, the present meta-analysis has demonstrated that health control beliefs have moderately strong links with global health appraisal, but it is worth noting that the magnitude of the links between such beliefs and specific health behaviour is modest. Wallston (1991) has maintained that HLOC cannot solely and sufficiently predict specific health behaviours, and the potential to carry out a health behaviour should be a joint function of health control beliefs and health values. We planned to test this notion by including health value as a moderator. However, our multiple literature search has identified no more than three reports for each specific health behaviour, making it impossible for performing moderation analyses in this study. The moderating role of health value should be examined if more of such work has been conducted in the future.

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Appendix

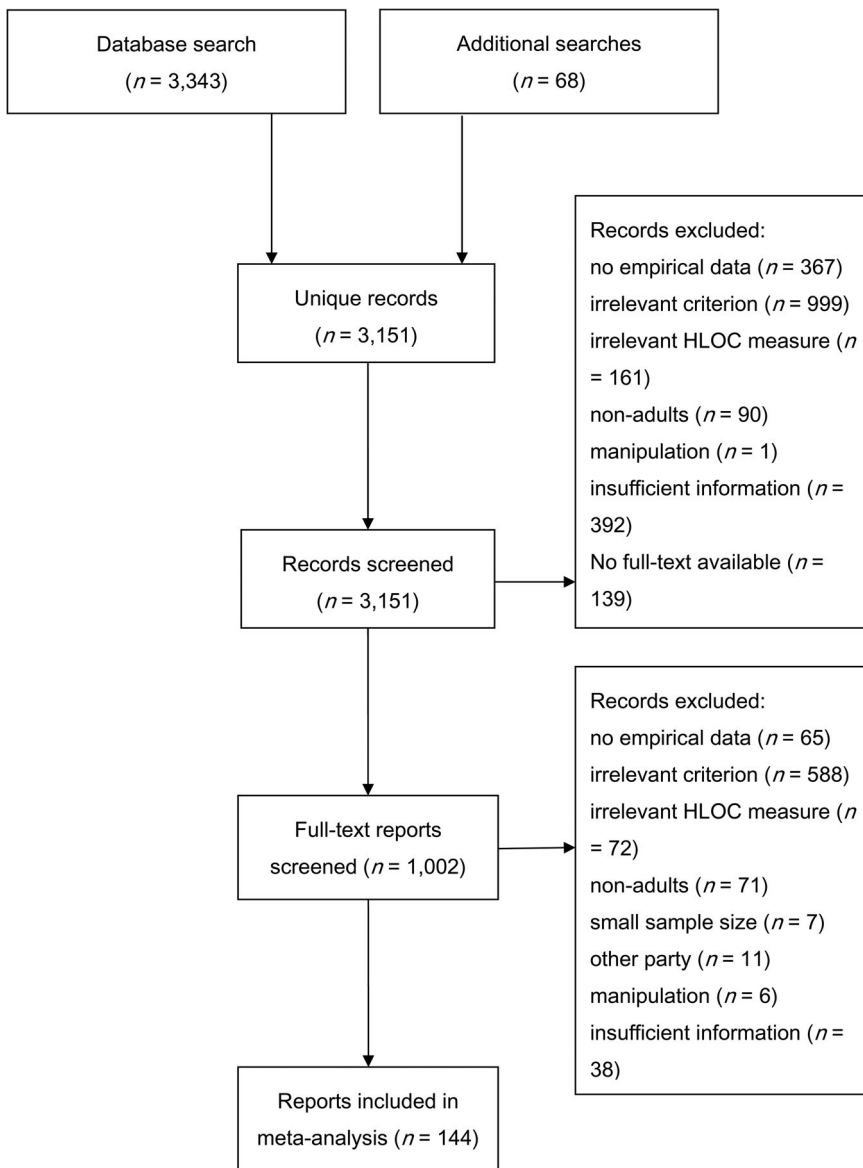


Figure A1. Flow chart for reports included in the meta-analysis.