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2 An Integrated Model of Condom Use in Sub-Saharan African Youth: A Meta-Analysis

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4
5 Cleo Protogerou

6 University of Cape Town and Curtin University

7 Blair T. Johnson

8 University of Connecticut

9 Martin S. Hagger

10 Curtin University and University of Jyväskylä

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14 Author notes

15 Cleo Protogerou, Department of Psychology, University of Cape Town, Cape Town, South Africa, and
16 Health Psychology and Behavioral Medicine Research Group, School of Psychology and Speech
17 Pathology, Faculty of Health Sciences, Curtin University, Perth, Australia; Blair T. Johnson,
18 Department of Psychological Sciences, University of Connecticut, Storrs, Connecticut, USA; Martin S.
19 Hagger, Health Psychology and Behavioral Medicine Research Group, School of Psychology and
20 Speech Pathology, Faculty of Health Sciences, Curtin University, Perth, Australia, and Faculty of Sport
21 and Health Sciences, University of Jyväskylä, Jyväskylä, Finland.

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31 Correspondence regarding this article should be addressed to Cleo Protogerou, Department of
32 Psychology, University of Cape Town, Cape Town, South Africa, email: cleo.protogerou@uct.ac.za

Abstract

Objective: We tested an integrated social cognitive model derived from multiple theories of the determinants of young peoples' condom use in Sub-Saharan Africa. The model comprised seven social cognitive antecedents of condom use: Attitudes, norms, control, risk perceptions, barriers, intentions, and previous condom use. **Methods:** We conducted a systematic search of studies including effects between at least one model construct and intended or actual condom use in young people from sub-Saharan African countries. Fifty-five studies comprising 72 independent data sets were included and subjected to random-effects meta-analysis. Demographic and methodological variables were coded as moderators. Hypotheses of the integrated model were tested using meta-analytic structural equation modeling. **Results:** The meta-analysis revealed significant non-trivial sample-weighted correlations among most model constructs. Moderator analyses revealed differences in six correlations for studies that included a formative research component relative to studies that did not. There was little evidence of systematic moderation of relations among model constructs by other candidate moderators. Meta-analytic structural equation models revealed significant direct effects of attitudes, norms, and control on condom use intentions, and of intention, control, and barriers on condom use. Including past condom use increased explained variance in condom use intentions and behavior but did not attenuate model effects. There were also significant indirect effects of attitudes, norms, and control on condom use through intentions. **Conclusions:** Findings provide preliminary evidence to support the integrated condom use model in sub-Saharan African youth. The model provides guidance on potential targets for improving the effectiveness of condom promotion interventions.

Keywords: HIV prevention; condom use; sub-Saharan Africa; youth; social-cognitive theories; theoretical integration; meta-analysis.

1 An Integrated Model of Condom Use in Sub-Saharan African Youth: A Meta-Analysis

2 Young people living in sub-Saharan Africa have an increased risk of sexual and reproductive
3 health problems, including unwanted pregnancies and sexually transmitted infections (STIs) (WHO,
4 2016). The sub-Saharan African region has the highest rates of new human immunodeficiency virus
5 (HIV) infections and the highest rates of unintended pregnancies in the world (Hubacher,
6 Mavranetzouli, & McGinn; Mayondi et al., 2015; UNAIDS, 2015). Similarly, the sub-Saharan African
7 population is affected by a high prevalence of other sexually-transmitted infections such as syphilis,
8 gonorrhea, bacterial vaginosis, trichomoniasis, and herpes simplex virus type 2 (Chico et al., 2012).
9 Unintended pregnancies and STI incidence are substantially reduced through use of barrier
10 contraceptives, and condom use has been identified as a key behavior in the prevention of both
11 outcomes. However, young people living in sub-Saharan Africa engage in inconsistent or low condom
12 use, despite repeated exposure to messages aimed at promoting condom use (Eggers, Aarø, Bos,
13 Mathews, & de Vries, 2014; Kalolo & Kibusi, 2015; Protogerou, Flisher, & Wild, 2014). Consequently,
14 condom promotion is a priority for public health and infection control among youth in sub-Saharan
15 African nations.

16 To date, a number of behavioral interventions aimed at promoting condom use in young people
17 have been implemented in sub-Saharan Africa. Reviews of the efficacy of these interventions typically
18 show favorable knowledge and attitude change, but limited or no change in condom use uptake and
19 maintenance (Eaton, Flisher, & Aarø, 2003; Exavery et al., 2012; Protogerou & Johnson, 2014; Scott-
20 Sheldon, Walstrom, Harrison, Kalichman, & Carey, 2013; Wamoyi et al., 2014). The poor success rate
21 demonstrates the need for public health interventions that are based on a fundamental understanding of
22 the determinants of condom use in this population. Interventionists have, therefore, turned to theories
23 from behavioral science and health psychology as basis for understanding condom use in this
24 population, and for informing the development of effective strategies to promote condom use.

1 Many theories applied to understanding and predicting condom use are based on the social
2 cognitive tradition (e.g., Bandura, 1986; Fishbein & Ajzen, 2009). These theories adopt an information
3 processing approach and focus on the individual, belief-based factors that affect decisions to engage in
4 health behavior (Conner & Norman, 2015). Prominent social cognitive constructs identified as
5 antecedents of health behavior in these theories include perceptions of severity and susceptibility to
6 disease, and perceived benefits and barriers (e.g., protection motivation theory, Rogers, 1975; the health
7 belief model, Rosenstock, Strecher, & Becker, 1988), attitudes, social norms, and perceptions of control
8 (e.g., the theory of planned behavior, Ajzen, 1985; the I-change model, de Vries, Mesters, van de Steeg,
9 & Honing, 2005; the reasoned action approach, Fishbein & Ajzen, 2009), knowledge, skills, and
10 estimation of costs and benefits (e.g., information-motivation-behavioral skills model, Fisher & Fisher,
11 1992; health action process approach, Schwarzer, 2008), and self-efficacy (e.g., social cognitive theory,
12 Bandura, 1986). Although some theories propose belief-based constructs as direct antecedents of health
13 behavior (e.g., health belief model, social cognitive theory), many propose motivation or *intentions* as
14 the most proximal predictor of behavior (Ajzen, 1985; Fishbein & Ajzen, 2009; Rogers, 1975).
15 Specifically, intentions are expected to mediate effects of beliefs on health behavior.

16 Social cognitive theories have shown considerable promise in explaining and predicting
17 variance in condom use, and informing the development of safer-sex interventions including condom
18 use. Reviews of research applying these theories to predict condom use, including those focusing on
19 populations in sub-Saharan Africa, have provided cumulative evidence of the psychological antecedents
20 of condom use (e.g., Albarracín, Johnson, Fishbein, & Muellerleile, 2001; Protogerou, Flisher, Aarø, &
21 Mathews, 2012; Sheeran, Abraham, & Orbell, 1999). However, one of the limitations of focusing on
22 specific theories is the potential to neglect particular constructs that may have relevance to the
23 prediction of the target behavior. In addition, there is considerable redundancy in constructs across
24 theories, such as constructs with similar content but labeled differently (Block, 1995; Hagger, 2014).
25 Integration of social cognitive theories may provide a solution to these problems through the

1 development of models that are inclusive, by incorporating conceptually-distinct constructs, yet,
2 parsimonious, by consolidating constructs with like content (Eggers et al., 2014; Hagger, Koch,
3 Chatzisarantis, & Orbell, 2017; Montaña & Kasprzyk, 2008). This goal can be achieved through
4 systematic classification of the social cognitive factors that feature in theories applied to the prediction
5 of health behavior, including condom use, into logical categories. Such classification necessitates close
6 examination of the content of constructs in social cognitive theories and their accompanying measures
7 and collapsing them to arrive at a nuanced, core set of constructs. McMillan and Conner (2007)
8 advocated a ‘core health cognitions’ approach to integration that classifies social cognitive variables
9 from theories based on definition and content to arrive at an optimally comprehensive set of constructs
10 derived from these theories.

11 **The Present Study**

12 Although conceptual and narrative reviews have identified the theory-based factors that relate to
13 condom use in sub-Saharan African youth (Eaton et al., 2003; Protogerou et al., 2012; Protogerou &
14 Hagger, 2017), there is, to date, no quantitative synthesis of single or integrated social cognitive
15 theories focusing on condom use in young people from sub-Saharan Africa. There is also very little
16 research on the effects of extraneous factors, such as demographic, environmental, and study
17 parameters, that may interact with psychological constructs from social cognitive theories in predicting
18 young people’s condom use across sub-Saharan African nations. There is, therefore, a need to
19 synthesize evidence from social cognitive theories that have been applied to explain condom use in this
20 population.

21 The present study addresses this need through a meta-analytic synthesis of research of the social
22 cognitive predictors of condom use in sub-Saharan African youth. We developed an integrated model
23 that includes a core set of social cognitive constructs expected to be associated with condom use (Figure
24 1). The model was guided by McMillan and Conner’s (2007) framework, which provides a basis to
25 classify multiple constructs from social cognitive models applied to health behavior into a set of core

1 constructs, along with the processes by which the constructs relate to behavior. Specifically, McMillan
2 and Conner put forth attitudes, self-representations, norms, control perceptions, and dispositions to act
3 (intentions) as the five conceptually distinct ‘core’ social cognitive correlates of health and risk
4 behavior. The attitudes construct encapsulates risk perceptions and perceived barriers from the health
5 belief model (Rosenstock et al., 1988) and protection motivation theory (Rogers, 1975), as well as
6 evaluations of the behavior and its outcomes from the theories of reasoned action and planned behavior
7 (Ajzen, 1985; Ajzen & Fishbein, 1980). We chose to retain the distinction between attitudes as beliefs
8 about the behavior, and risk perceptions and perceived barriers in our model considering the potential
9 utility of identifying unique effects for each factor in the development of condom use interventions. The
10 control construct encompasses beliefs relating to self-efficacy from social cognitive theory (Bandura,
11 1986), and perceived behavioral control from theories of reasoned action and planned behavior. Norms
12 encompass the injunctive and descriptive norms constructs that feature prominently in social cognitive
13 theory, the theories of reasoned action and planned behavior, the reasoned action approach, and social
14 identity approaches (e.g., White, Terry, & Hogg, 1994). Following McMillan and Conner, we predicted
15 that effects of these core constructs on condom use would be mediated by dispositions to act, captured
16 by the intentions construct, consistent with previously specified models (e.g., Ajzen, 1985; Fishbein &
17 Ajzen, 2009; Rogers, 1975). Alongside this hypothesis, we also proposed direct effects of control
18 perceptions and barriers on condom use. This is consistent with the premise that when control
19 perceptions equate to actual control and real barriers, they serve as ‘proxy’ measures of actual barriers
20 and likely to predict condom use directly, bypassing intentions (Ajzen, 1985; Fishbein & Ajzen, 2009).
21 Overall, McMillan and Conner’s framework enabled us to identify a core set of condom use antecedents
22 and propose testable hypotheses for the relations among them.

23 We aimed to synthesize research on theories that include constructs from the integrated model
24 and test their effects on condom use in sub-Saharan African youth. In addition to examining the
25 averaged sample-weighted correlations for each relation among model constructs, our analysis also

1 permitted testing predictions of the integrated model in a nomological network (Hagger, Gucciardi, &
2 Chatzisarantis, 2017). Specifically, we tested the unique prediction of the core components on the
3 model on condom use, mediated by intentions, in a meta-analytic structural equation model (Cheung,
4 2015). We also expected model effects to hold when controlling for past condom use, an important pre-
5 requisite in support of the predictive validity of social cognitive models (Hagger, Chan, Protogerou, &
6 Chatzisarantis, 2016; Ouellette & Wood, 1998), and compared model effects across models that include
7 and exclude past condom use as a control variable (Figure 2). In addition, we tested the effects of
8 candidate demographic (age, gender, socio-economic status, religion, geographical location) and
9 methodological (time since publication, time lag between psychological and follow-up behavior
10 measures, sample context, study quality, inclusion of formative research) moderators on relations
11 among the social cognitive constructs, and condom use intentions and behavior. These moderators have
12 been identified as factors likely to magnify or diminish the relationship between constructs from social
13 cognitive theories and condom use in young sub-Saharan African populations (Eggers et al., 2016;
14 Protogerou & Hagger, 2017). In the event of substantive moderation, we tested differences in model
15 effects using separate meta-analytic structural equation models in groups of studies representing each
16 level of the moderator.

17 **Method**

18 **Search Strategy**

19 We conducted a search of electronic databases including Web of Science, PubMed, PsycINFO,
20 and Google Scholar up to August 2016. In addition, we hand-searched reference lists of studies
21 included from the database search, as well as relevant systematic reviews and meta-analyses, for
22 additional eligible studies. Each sub-Saharan African country's name was a key word in the literature
23 search, in addition to 'Sub-Saharan Africa', 'West Africa', 'East Africa', 'Southern Africa', and 'South
24 Africa'. We combined these words with key terms describing sexual risk-taking ('sex', 'condom',
25 'HIV', 'AIDS', 'sexually transmitted disease', 'STD', 'sexually transmitted infection', and 'STI').

1 Moreover, we combined the above terms with the names of separate social cognitive theories and
2 variations of the core constructs drawn from McMillan and Conner's classification system.

3 **Selection criteria**

4 Studies were included if they: (a) sampled young people from sub-Saharan African nations in
5 educational (i.e., elementary, high-school, and higher education students) or non-educational settings
6 (e.g., households, community settings); (b) were cross-sectional, prospective, or intervention-type
7 designs; (c) used a measure of intended or actual condom use as an outcome variable; (d) provided at
8 least one bivariate correlation between a social cognitive construct falling into seven identified
9 construct categories and condom use; and (e) were full-text peer-reviewed published articles and
10 unpublished theses, written in English. Studies were excluded if they: (a) did not employ condom use as
11 an outcome variable but employed other safer-sex or condom-use related behaviors (e.g., hormonal
12 contraception, abstinence, delaying intercourse, condom use at first intercourse, purchasing, carrying,
13 and negotiating condoms); (b) used composite outcome variables that included some parameter of
14 condom use (e.g., averages of condom use and illegal substance use); (c) were duplicate versions of the
15 original study (e.g., abstract-only report, conference presentation); and (d) were qualitative designs,
16 government reports, and editorial/opinion pieces. There were no publication date restrictions. Following
17 UNESCO's (2017) conceptualization of youth as "...a period of transition from the dependence of
18 childhood to adulthood's independence and awareness of our interdependence as members of a
19 community" (para. 1), and the African Youth Charter's definition of youth as people between 15 and 35
20 years (African Union Commission, 2006), we included studies that had sampled people up to age 35.
21 Two co-authors independently screened the abstracts for eligibility; then the full copies of eligible titles
22 were screened using a priori inclusion-exclusion criteria, which resulted to the final list of included
23 studies. Study selection and reasons for exclusion are presented in a flow chart (Figure 3) based on
24 PRISMA guidelines (Moher, Liberati, Tetzlaff, Altman, & The PRISMA Group, 2009).

25 **Classification of constructs**

1 Guided by our proposed model based on McMillan and Conner's (2007) 'core health cognitions'
2 framework, we identified constructs from eight social cognitive theories applied to condom use in the
3 included studies: the theories of reasoned action and planned behavior (Ajzen, 1985; Ajzen & Fishbein,
4 1980); the health belief model (Rosenstock et al., 1988); social cognitive theory (Bandura, 1986);
5 information-motivation-behavioral skills model (Fisher & Fisher, 1992); the health action process
6 approach (Schwarzer, 1992); the AIDS risk-reduction model (Catania, Kegeles, & Coates, 1990);
7 protection motivation theory (Rogers, 1975); and the I-change model (de Vries et al., 2005). Constructs
8 from these theories were matched with one of the seven constructs in our model: attitudes, norms,
9 control, risk perceptions, barriers to condom use, intentions, and previous condom use. The process
10 required a content analysis of the measure tapping the study construct and matching it with the
11 appropriate model construct. We allocated 'content to category', matching independently, and
12 compared our classifications. The classifications were the identical, which was expected, given that
13 most studies used inventories developed by the social cognitive theorists themselves. Protogerou and
14 Hagger (2017) describe the detailed process of construct classification.

15 **Data Extraction**

16 As all studies included in the current analyses were correlational in design, the zero-order
17 Pearson correlation coefficient (r) was selected as the effect size metric. Effect sizes and associated
18 sample sizes for relations among the model constructs were extracted from the source studies. In cases
19 where an effect of interest was tested but insufficient statistics were reported to compute an effect size,
20 we requested the data from the study authors. We also approached authors if information relevant to
21 candidate moderators was missing. In the event that zero-order correlation coefficients among variables
22 were not available but other effect size statistics were (e.g., t -tests, χ^2 , odds ratios), we used these to
23 produce zero-order correlation coefficients using appropriate transformations. In cases where studies
24 included multiple measures of the dependent variable, we used the measure that was most closely
25 matched to the target behavior (frequency of condom use). For studies that included relationships

1 between condom use and more than one measure of the seven core social cognitive constructs identified
2 a priori (e.g., self-efficacy and perceived behavioral control), we produced an aggregated effect size by
3 taking the average of the effects (Marín-Martínez & Sánchez-Meca, 1999). For studies that had adopted
4 a prospective design and included follow-up measures of condom use behavior on multiple occasions,
5 we used the dependent measure taken at the most distal time point to compute the effect size given that
6 long-term follow up behavioral data are relatively rare in this literature. Of the 12 eligible prospective
7 studies included in the analysis, only one had multiple follow-up measures of condom use.

8 **Appraisal of Study Quality**

9 Quality of included studies was appraised using the evidence-based librarianship (EBL) critical
10 appraisal checklist (Glynn, 2006) and was included as a moderator of model effects. Study quality was
11 evaluated on four domains: population (e.g., representativeness, appropriateness of selection criteria,
12 response rate); data collection (e.g., clarity and validation of instruments, inclusion of instruments in
13 report); study design (e.g., appropriateness of methodology, replicability, ethics approval); and results
14 (e.g., clarity and accuracy of results, recommendations for future research, external validity). Each
15 research domain is critically appraised by checking a yes, no, unclear, or not applicable, next to each
16 criterion. “Yes” responses were assigned a score of (1), “no” responses were assigned a score of (2),
17 “unclear” responses were assigned a score of (3), and “not applicable” responses were assigned a score
18 of (4). A total score (per quality domain items or for all items) was computed by dividing the “yes”
19 answers by the total number of items. Finally, in line with the tool’s guidelines, we created a
20 dichotomous study quality variable. Studies receiving a total score of less than 75% were considered of
21 questionable quality, while studies with a total score of 75% or above were considered of acceptable
22 quality. All included studies were scored by one co-author, with a second co-author assessing the
23 quality of 15 randomly selected studies.

24 **Moderator Coding**

1 We coded studies into groups on the following moderator variables: participant age (younger or
2 older); gender (predominately male, predominately female, balanced, male-only, or female-only);
3 socio-economic status (high, low, or not stated); predominant religion (Christian, other, or not stated);
4 geographical location (peri-urban, rural, or both); sample context (school, higher education, or
5 community); study quality (acceptable or questionable); and the inclusion of a preliminary formative
6 research component (included or not included). In addition, time since publication (defined as number
7 of years since publication to the end of the current search period), time lag between measures of social
8 cognitive constructs and follow-up measures of behavior (measured in weeks), and study quality were
9 treated as continuous moderators. Testing for age as a moderator presented some challenges, as there
10 was substantive within-study variability in the age of participants. We therefore performed moderator
11 analyses with age as a categorical variable, defined as above or below the sample median of 18.5, and
12 as a continuous variable using the sample average. This value corresponds with the end of adolescence,
13 when young people are expected to assume many more responsibilities (UNESCO, 2017). However, we
14 recognize the inherent limitations of dichotomizing age, and of using the sample average as a
15 continuous variable, which does not account for within-study variability. We also conducted moderator
16 analyses with study quality as a categorical and continuous variable given that methodological tools
17 have, by convention, been dichotomized into ‘acceptable’ and ‘questionable’ categories according to
18 guideline cutoff scores, but can also be treated as a continuous variable (Johnson, Low, & MacDonald,
19 2014). The extant literature has suggested that all these variables have the potential to influence the
20 relationship between social cognitive constructs and condom use in sub-Saharan African settings
21 (Eggers et al., 2016; Protogerou & Hagger, 2017; Protogerou & Johnson, 2014). Nonetheless, sub-
22 Saharan African studies have also found that these variables can either increase, or decrease, or leave
23 the relationship between social cognitive constructs and condom use unaffected (e.g., Bryan, Kagee, &
24 Broaddus, 2006; Heeren, Jemmott, Mandeya, & Tyler, 2008; Protogerou, Flisher, Wild, & Aarø, 2013).

1 Given these inconsistencies, we made no a priori predictions about the direction of moderator effects
2 and viewed all moderator analyses as exploratory.

3 **Data Analysis**

4 Random-effects meta-analysis was used to compute averaged sample-weighted correlations (r_+)
5 among model constructs using Hedges and Vevea's (1998) methods and SPSS macros developed by
6 Field and Gillett (2010). The averaged sample-weighted correlations were considered non-trivial in
7 value if they equaled or exceeded a small effect size ($< .10$) in Cohen's (1992) taxonomy of effect sizes.
8 We also conducted heterogeneity tests of the averaged correlations using Cochran's (1952) Q and the I^2
9 statistics (Higgins & Thompson, 2002). Statistically significant Q values and I^2 values exceeding 25%
10 are indicative of substantial heterogeneity in the correlations (Higgins & Thompson, 2002). We
11 evaluated the presence of small-study bias in the averaged sample-weighted correlations by computing
12 statistics based on plots of the correlations from each study against study precision (usually the
13 reciprocal of the study sample size). Asymmetry in the predicted 'funnel' shape of the plots is
14 considered evidence of small study bias, that is, the tendency for studies included in the analysis to
15 exhibit large effects relative to their size. This is often taken as a potential indicator of publication bias.
16 We used Begg and Mazumdar's (1994) rank-order correlation to test for the interdependence of
17 variance and effect size, with a significant correlation indicating the presence of publication bias.

18 Effects of categorical moderator variables on the correlations among model constructs were
19 tested by conducting separate meta-analyses for correlations among constructs in groups of studies
20 defined by each level of the moderator (e.g., younger and older participants). Comparisons were made
21 using 95% confidence intervals about the averaged sample-weighted correlations in each moderator
22 group with a formal test provided by Welch's t -test. Categorical moderator analyses were conducted in
23 cases where there were at least two studies at each level of the moderator. We also conducted a series of
24 multi-variable meta-regression analyses to examine effects of moderators that were continuous in
25 format (e.g., study quality, average sample age, time lag between measures of psychological constructs

1 and follow-up measure of condom use, time since publication) using Wilson's (2001) Metareg macros
2 for SPSS. As moderator variables may be related, the meta-regressions also allowed us to examine
3 unique effects of selected categorical and continuous moderator variables on the correlations among
4 model variables. As the numbers of studies that included a follow-up measure of condom use numbered
5 very few ($k = 12$), we opted to conduct single-variable meta-regressions for the time lag moderator to
6 maximize statistical power, but we acknowledge the limitation of this analysis as it does not test the
7 unique effect of this moderator when controlling for other moderators. In this analysis, we did not
8 predict that time lag would moderate correlations among concurrently-measured variables. However,
9 recognizing that effects in prospective models tend to decline over time (Gollob & Reichardt, 1987), we
10 expected effects between psychological variables and prospectively-measured condom use would be
11 smaller with increasing time lag. In instances where a moderator indicated a significant prediction of
12 the effect size, we used the moving constant technique to estimate the conditional effect size (and its
13 statistical significance) at meaningful levels of the moderator, such as the mean and one standard
14 deviation above and below the mean (Johnson & Huedo-Medina, 2011). The analysis involves
15 subtracting the conditional moderator value of interest from each moderator, re-running the meta-
16 regression, and repeating as necessary. The analysis produces an index of moderation (Q_M) and
17 conditional values of the correlation (\hat{r}) at the conditional levels of the moderator.

18 Hypothesized relations among constructs in the integrated model were tested through meta-
19 analytic structural equation modeling using the MASEM package (Cheung, 2015; Cheung & Hong,
20 2017) on R (R Development Core Team, 2017). Traditional approaches to analyzing multiple relations
21 among social cognitive variables have typically adopted a univariate approach, which involves
22 subjecting matrices of averaged sample-weighted correlations among variables in the model, derived
23 from meta-analysis, to path analysis (Hagger, Chan, et al., 2016; Hagger & Chatzisarantis, 2016). Such
24 approaches have inherent limitations such as using the same sample size to estimate the models and
25 treating the averaged correlation matrix as a covariance matrix, which may lead to inaccuracies in the

1 estimated standard errors, confidence intervals, and χ^2 values of the resulting models (Cheung, 2015).
2 The meta-analytic structural equation modeling approach is a two-stage alternative that overcomes the
3 limitations of the univariate approach. In the first stage, transformations are applied to correlation
4 matrices from individual studies to account for study-specific random effects so that they can be
5 analyzed as covariance matrices a structural equation model. Specifically, the analysis yields a pooled
6 correlation matrix, which represents the estimated average correlation matrices of the population, and
7 the associated asymptotic sampling covariance matrix, representing the precision of the estimated
8 average correlation matrix. In the second stage, the a priori model is fitted to the covariance matrix
9 from the first stage. Missing data are handled by use of full information maximum likelihood
10 estimation¹.

11 We estimated two models in our meta-analytic structural equation modeling analysis: A model
12 testing the hypothesized effects among study constructs as stipulated in the proposed integrated model
13 (Figure 1), and a modified model that included past condom use as a predictor of all other constructs in
14 the model (Figure 2). Fit of the proposed model with data from the meta-analysis was evaluated using
15 multiple goodness-of-fit indices: the model goodness-of-fit χ^2 , the comparative fit index (CFI), the
16 Tucker-Lewis index (TLI), the standardized root mean square of the residuals, and the root mean error
17 of approximation (RMSEA). A non-significant χ^2 , and CFI and TLI values that approach or exceed .95,
18 a SRMSR value of less than .008, and a RMSEA value of .005 or less indicate good fit of the model
19 with the data (Hu & Bentler, 1999). Variability about parameter estimates including direct and indirect
20 effects was estimated using likelihood-based confidence intervals. Likelihood based confidence
21 intervals have an advantage of Wald confidence intervals based on the standard errors as they capture
22 asymmetry in the parameter distributions (Cheung, 2007, 2009). Based on guidelines proposed by
23 Seaton, Marsh, and Craven (2010) we adjudged a .10 value for parameter estimates to be the minimum
24 considered for the effect to be non-trivial and have “meaningful value”, with smaller values (< .075)

¹See other sources for a full account of meta-analytic structural equation modeling approach (Cheung, 2015; Cheung & Hong, 2017), and online materials with worked examples are available at <https://courses.nus.edu.sg/course/psycwlm/internet/metaSEM/masem.html>

1 regarded as unsubstantial, even if they achieve statistical significance. We evaluated whether inclusion
2 of past condom use as a predictor in the model would result in an attenuation of effects of study
3 constructs (attitudes, norms, control, risk perceptions, and barriers) on intentions, and of intentions on
4 behavior, by comparing the confidence intervals of the parameter estimates from the model excluding
5 past behavior, with those from the model including past behavior. In cases where our moderator
6 analyses indicated systematic effects of a moderator on relations among model constructs, we estimated
7 the meta-analytic structural equation model in sets of studies at each level of the moderator.
8 Heterogeneity statistics from the first stage of the model were used to evaluate whether the moderator
9 had resolved the heterogeneity in correlations among variables. We used Schenker and Gentleman's
10 (2001) standard method to test for differences in parameter estimates at each level of the moderator.
11 Specifically, we computed 95% confidence intervals about the difference in the parameter estimates of
12 interest. Confirmation of a statistically significant difference in a parameter estimate was supported if
13 the confidence interval did not contain zero.

14 **Results**

15 **Study Characteristics**

16 Fifty-five studies, comprising 72 independent data sets ($N = 55,069$), were included in the meta-
17 analysis. A list of included studies is provided in Appendix A (supplemental materials) and study
18 characteristics are summarized in Appendix B (supplemental materials). Studies appeared between
19 1992 and 2016 as published journal articles ($k = 50, 91\%$) or postgraduate dissertations ($k = 5, 9\%$).
20 Most studies employed a cross-sectional design ($k = 43, 75\%$) and reported a preliminary formative
21 research phase ($k = 34, 64\%$). Average sample age ranged between 12.1 and 26.5 ($M = 19, SD = 3.43$).
22 Male participants were over-represented, with 23 studies (42%) including predominately-male samples
23 (male composition $> 50\%$), and 13 studies (24 %) including male-only samples. Thirteen sub-Saharan
24 African nations were represented (Botswana, Cameroon, Ethiopia, Ghana, Guinea, Kenya, Namibia,
25 Nigeria, Rwanda, South Africa, Tanzania, Uganda, and Zimbabwe), with a large number of studies

1 being conducted in South Africa ($k = 16, 29\%$). About half of the studies were conducted in (peri)urban
2 ($k = 30, 54\%$) and school settings ($k = 27, 49\%$).

3 **Appraisal of Study Quality²**

4 The majority of studies ($k = 45, 88\%$) received a total score of $< 75\%$ on the EBL checklist
5 indicating questionable overall quality. In terms of the separate domains of the checklist, studies
6 exhibited highest quality scores in the *results* validity domain ($M = 65.45, SD = 25.37$), with most
7 studies reporting results clearly ($k = 47, 85\%$), accurately ($k = 42, 76\%$), and completely ($k = 48, 87\%$).
8 Studies received the lowest quality scores in the *sample* validity domain ($M = 42.75, SD = 22.59$),
9 revealing potential selection/sampling ($k = 38, 69\%$) and representativeness ($k = 25, 45.5\%$) biases.
10 Inspection of individual checklist items revealed that the strongest study domain was the reporting of
11 results, with 48 studies reporting full disclosure of findings (87.3%). The weakest study domain was
12 replicability with only ten studies (18%) providing sufficient methodological detail to allow replication.
13 Inter-rater reliability analysis indicated substantial agreement in study quality ratings across all items
14 (mean Cohen's $\kappa = .73, 95\% CI = .67, .80$) and total study quality scores (intraclass correlation = .949,
15 $p < .001$) for the randomly selected sub-sample of studies.

16 **Sample-Weighted Correlations**

17 Averaged sample-weighted correlations among model constructs in the meta-analysis appear in
18 Table 1, along with confidence intervals, heterogeneity tests, and publication bias statistics³. The
19 averaged correlations among all but seven of the constructs were statistically significant and of
20 sufficient size to be considered non-trivial⁴. However, correlations between barriers and all other

²Scores on the study quality checklist for each study are available on the Open Science Framework (<https://osf.io/usrw8/>).

³Raw data and analysis files are available on the Open Science Framework (<https://osf.io/usrw8/>).

⁴There were no studies available to compute effect sizes for two effects: barriers-condom use and barriers-risk perceptions leaving two empty cells in our correlation matrix. In order to complete the correlation matrices for subsequent model test, we filled the empty cells with effect sizes from studies that closely represented the constructs and population of interest. For the barriers-future condom use effect, the effect size was sourced data from Sheeran et al.'s (1999) meta-analysis of the psychosocial correlates of heterosexual condom use. For the barriers-risk perceptions effect, data were taken from Winfield and Whaley's (2002) test of the health belief model in African-American students. While neither study was on sub-Saharan African youth, these effect sizes are the closest estimates for these effects available in the extant literature. In addition, only one study included in the current analysis tested the risk perceptions-condom use effect, so this effect in the matrix is the raw effect size that has not been weighted by sample size.

1 constructs, between attitudes and risk perceptions, and between control and condom use, were not
2 statistically significant, with confidence intervals that included zero. Levels of heterogeneity ranged
3 from small to moderate in the current sample according to Q and I^2 statistics.

4 **Moderator Analyses**

5 Results of categorical moderator analyses are presented in Appendix C (supplemental
6 materials), and results of meta-regression analyses are presented in Appendixes D and E (supplemental
7 materials). We found relatively few effects of the moderators on model relations for moderator analysis
8 with categorical moderator variables (Appendix C). The formative research moderator had the most
9 pervasive effect with six of the 25 relations⁵ among the integrated model variables demonstrating
10 significant differences. Specifically, the effects of attitudes on risk perceptions, intentions, and past
11 condom use, the effects of norms and control on risk perceptions, and the effects of intentions on
12 condom use, were stronger for studies that included a formative research component, compared with
13 studies that did not. In contrast, we found few moderator effects for the participant age, gender, socio-
14 economic status, predominant religion, geographical location, sample context, and study quality
15 moderators.

16 Focusing on the meta-regression analyses, the single-variable meta-regression analyses revealed
17 significant effects of time lag on study effect size for relations between attitudes and norms, ($\beta = .758, p$
18 $< .001$), attitudes and intentions ($\beta = .541, p = .020$), and norms and intentions ($\beta = .626, p = .006$)
19 (Appendix D). Examining the correlations at conditional values of time lag (Appendix E) indicated
20 larger correlations when the time lag was longer for these three relations. Multi-variable meta-
21 regression analyses, in which study effect sizes were regressed on continuous (age, study quality score,
22 time since publication) and dichotomous categorical (formative research) moderators, revealed
23 formative research as a consistent predictor of correlations among study variables (Appendix D).

⁵Our model comprised 28 relationships among constructs. However, two relationships were excluded from the moderator analysis because they were not tested by any study in our sample (we filled these empty cells with data from with Sheeran et al.'s (1999) and Winfield and Whaley's (2002) studies), and a further relationship (risk perceptions-condom use) was excluded because only one study tested it.

1 Specifically, the effects of attitudes on norms ($\beta = -.472, p = .014$), risk perceptions ($\beta = -.661, p =$
2 $.004$), intentions ($\beta = -.399, p = .016$), and past condom use ($\beta = -.411, p = .035$) were all larger in
3 studies that included formative research, corroborating the categorical moderator analyses for this
4 variable (Appendix C). In addition, we found significant effects of age for the attitude-norms ($\beta = -.573,$
5 $p = .001$), attitudes-risk perceptions ($\beta = -.642, p < .001$), norms-control ($\beta = -.483, p = .012$), and
6 intentions-past condom use ($\beta = .911, p < .001$) relationships. An examination of the conditional values
7 for this moderator (Appendix E) indicated that correlations were generally larger in younger samples,
8 with the exception of the intentions-past condom use relationship for which no significant differences in
9 the effect size were found at each level of the moderator (Appendix E). The multi-variable meta-
10 regressions also revealed a statistically significant effect of study quality on the attitude-risk perceptions
11 relationship ($\beta = -.937, p = .025$; Appendix D). However, examination of the correlation at conditional
12 values of study quality did not reveal statistically significant differences in the effect across levels of
13 study quality (Appendix E).

14 **Meta-Analytic Structural Equation Models⁶**

15 Standardized parameter estimates and likelihood-based confidence intervals for the meta-
16 analytic structural equation model of the integrated condom use model excluding past behavior, and the
17 model including past condom use are presented in Figures 1 and 2, respectively. In addition, indirect
18 effects, confidence intervals of parameter estimates, and tests of difference in path coefficients across
19 the models including and excluding past condom are provided in Appendix F (supplemental materials).
20 The model excluding past condom use exhibited good fit with the data ($\chi^2 = 8.212, df = 3, p = .042$; CFI
21 $= .991$; TLI $= .934$; SRMSR $= .036$; RMSEA $= .005$). Model parameter estimates revealed statistically
22 significant, non-trivial direct and positive effects of attitudes, norms, and control on condom use
23 intentions, while effects for risk perceptions and barriers were not significant and trivial in size. We also
24 found statistically significant, non-trivial direct and positive effects of intention and control on condom

⁶Raw correlation matrices, analysis scripts for R, and output from the R workspace can be found at <https://osf.io/usrw8/>

1 use, and negative effects of barriers on condom use⁷. In addition, the analysis yielded statistically
2 significant indirect effects of attitudes, norms, and control on condom use mediated by intentions⁸.
3 Indirect effects of risk perceptions and barriers on condom use were not statistically significant. The
4 model accounted for statistically significant non-zero proportions of the variance in intentions (24.88%)
5 and condom use (14.73%). Overall, results supported the hypothesized pattern of effects in the
6 proposed model. The model including past condom use as a predictor also exhibited good fit with the
7 data ($\chi^2 = 3.728$, $df = 3$, $p = .292$; CFI = .999; TLI = .991; SRMSR = .022; RMSEA = .002). The
8 inclusion of past condom use resulted in some observed reductions in the magnitude of the effects of
9 intention and control on condom use. However, these reductions were not statistically significant
10 according to the standard method (Schenker & Gentleman, 2001; Appendix F). The inclusion of past
11 behavior also resulted in no significant differences in the magnitude of the indirect effects of attitudes,
12 norms, and control on behavior mediated by intention. There were non-trivial, statistically significant
13 effects of past condom use on all model variables and statistically significant total indirect effect of past
14 condom use on condom use mediated by the social cognitive variables. Inclusion of past condom use as
15 a predictor in the model resulted in a minor increase in the proportion of variance explained in condom
16 use intentions (26.39%), and a much larger increase in variance explained in behavior (29.71%),
17 reflecting the substantive direct effect of past condom use on future condom use.

18 Given the pervasive effect of the formative research moderator, we aimed to examine whether
19 the pattern of relations in the integrated condom use model varied in groups of studies that included
20 formative research and those that did not. We therefore set out to conduct separate meta-analytic
21 structural equation models in groups of studies determined by the formative research moderator and

⁷The direct effect of perceived behavioral control on behavior has been identified as a conditional effect in the theory of planned behavior (Ajzen, 1991). Ajzen proposed that when perceived behavioral control approximated actual control, that is, served as a proxy measure of control, it should directly predict behavior, but otherwise its influence should be directed through intention.

⁸Although the sizes of the indirect effects were much smaller compared to the direct effects, they should not be interpreted using the same effect size criteria as they are produced by computing the product of the direct effects.

1 compare the magnitude of the effects⁹. However, several of the model relations were not tested in the
2 group of studies without a formative research component, which meant that several of the cells in the
3 pooled correlation matrix were empty, precluding estimation of the model in this group. So we
4 conducted a sensitivity analysis to evaluate whether our conclusions regarding the pattern of effects in
5 our model were affected by excluding studies that did not include a formative research component ($k =$
6 31). The model for the sample of studies excluding studies without a formative research component
7 exhibited satisfactory fit with the data ($\chi^2 = 3.940$, $df = 3$, $p = .268$; CFI = .999; TLI = .989; SRMSR =
8 .031; RMSEA = .003)¹⁰. Full model results appear in Appendix G (supplemental materials)¹¹. There
9 were no significant differences in the pattern of effects in the model estimated in the full sample of
10 studies and the model estimated in the sample of studies excluding studies without a formative research
11 component according to the standard method (Schenker & Gentleman, 2001; Appendix G). As we
12 found little evidence of systematic moderation of relations among study variables for any of the other
13 moderator variables, we did not conduct additional moderator or sensitivity analyses of model effects
14 for any of the other moderators.

15 **Publication Bias**

16 Begg and Mazumdar's (1994) rank correlation test suggested little evidence of systematic
17 publication bias across effects among model constructs. The test revealed potential bias in three of the
18 25 averaged sample-weighted correlations: norms–risk perceptions ($\tau(k = 7) = -.714$, $p = .024$),
19 control–intentions ($\tau(k = 37) = -.251$, $p = .029$), and control–condom use ($\tau(k = 8) = .571$, $p = .048$).

20 **Discussion**

21 The purpose of the current research was to develop an integrated model of the determinants of
22 young peoples' condom use in sub-Saharan Africa, meta-analyze studies adopting model constructs to

⁹Given the importance of including past behavior in the model, we only estimated the version of the integrated model that included past behavior at each level of the moderator.

¹⁰Goodness-of-fit statistics for the model in the full sample was identical to model fit for the previously-estimated full-sample model including past behavior.

¹¹Likelihood-based 95% confidence intervals could not be computed for some of the direct effects in the model excluding studies without a formative research component, most likely due to small sample sizes. In this case Wald CIs are provided for the direct effects in this model. However, likelihood-based confidence intervals were computed for the indirect effects.

1 predict condom use in this population, and test the model using meta-analytic structural equation
2 modeling. We also aimed to assess the impact of candidate moderators on the obtained relationships
3 among theoretical constructs and between theoretical constructs and condom use. The model was
4 developed from research applying social cognitive theories to condom use with model constructs
5 classified along the lines of McMillan and Conner's (2007) 'core health cognitions' approach.
6 Attitudes, norms, control, risk perceptions, barriers to condom use, intentions, and previous condom
7 use, were included in the proposed model, with intentions serving to mediate the effects of the core
8 constructs on condom use. We identified studies including correlations among these constructs in a
9 comprehensive database search and subjected them to random-effects meta-analysis. Studies were also
10 coded into groups on the following moderator variables: age, gender, socio-economic status, religion,
11 geographical location, time from publication, sample context, study quality, follow-up time lag, and
12 inclusion of formative research. We found statistically significant averaged sample-weighted
13 correlations among the majority of the model constructs (i.e., all but seven). Testing the proposed
14 model using meta-analytic structural equation modeling revealed significant, direct, non-trivial, positive
15 effects of attitudes, norms, and control on condom use intentions. We also found significant, positive,
16 non-trivial effects of intention and control on condom use, and a significant negative effect of barriers
17 on condom use. In addition, we found significant indirect effects of attitudes, norms, and control on
18 condom use, mediated by intentions. Inclusion of past behavior in the model resulted in some observed
19 attenuation of effects in the model, particularly the effect of control on condom use, but there were no
20 significant differences. Past behavior also accounted for a substantive proportion of the variance in
21 condom use. Moderator analyses revealed few differences on study variables across moderator groups.
22 Of the moderators, the inclusion of formative research had the most pervasive effect on model relations.
23 A sensitivity analysis using meta-analytic structural equation model was conducted to test whether
24 exclusion of studies that did not include a formative research component altered our conclusions with

1 respect to model effects. The analysis revealed that proposed model effects hold with no substantive
2 variation in effect sizes as a result of excluding studies without formative research.

3 **Implications for the Integrated Model**

4 The integrated condom-use model accounted for substantial variance in condom use intentions
5 and actual behavior in sub-Saharan African youth. Attitudes, norms, control, and barriers to condom use
6 were prominent predictors, while risk perceptions had weak effects. Results are broadly consistent with
7 research that has applied social cognitive theories such as protection motivation theory and the theory
8 of planned behavior to condom use in other populations (e.g., Albarracín et al., 2001; Bengel, Belz-
9 merk, & Farin, 1996; Sheeran & Orbell, 1998), although the sizes of the effects, particularly the
10 intentions-condom use relationship were smaller in the current study. It is important to note that effect
11 sizes of attitudes, norms, and control factors on behavior through intentions were similar in magnitude.
12 Norms may have an important role in this context, and similar findings have been reported in research
13 applying social cognitive theories such as the theory of planned behavior and the reasoned action
14 approach to condom use and other risk behaviors (McEachan, Conner, Taylor, & Lawton, 2012;
15 McEachan et al., 2016; Rich, Brandes, Mullan, & Hagger, 2015; Sheeran et al., 1999). Given the equal,
16 additive effects of the three components, interventions that target all three sets of beliefs may be
17 effective in promoting condom use. Therefore, messages that promote the advantages of condom use
18 and downplay drawbacks, promote obligation to sexual partners and significant others, and enhance
19 confidence in using condoms may be optimally effective strategies to enhance condom use. In the
20 present analysis, the direct negative effect of barriers on condom use and the lack of an indirect effect
21 through intentions, suggests that perceived barriers to condom use (e.g., perceived stigma, beliefs in
22 reduced pleasure or effectiveness, religious beliefs) may be less influential than actual barriers (e.g.,
23 access to condoms and refusal of partners to use condoms). These findings are consistent with the
24 premise of the theory of planned behavior (Ajzen, 1985) that control-related perceptions and barriers
25 will directly predict behavior to the extent that they align with actual constraints on behavior. These

1 findings also support a basic premise of the health belief model (Rosenstock et al., 1988), which
2 specifies direct effects of beliefs about barriers on health behavior. Reducing these barriers may also be
3 an appropriate avenue for intervention. The non-significant, trivial effect of risk perceptions is
4 consistent with previous studies that have tested the unique effects of risk perceptions on health
5 behavior in integrated models (e.g., Barg et al., 2012; Hattar, Pal, & Hagger, 2016; Maher & Conroy,
6 2016). It seems that beliefs about benefits and costs, significant others' influence, and personal capacity
7 are more salient than beliefs relating to risk. In the context of condom use this is extremely pertinent as
8 many campaigns and educational programs aimed at condom use have focused on raising individuals'
9 awareness about risk including highlighting perceptions of vulnerability to STIs and the severity of
10 these conditions (e.g., Harvey, Stuart, & Swan, 2000). Such approaches may be less effective compared
11 to targeting personal beliefs on condom use.

12 The inclusion of past condom use in the model led to observed attenuation of some of the effects
13 in the model and a strong direct effect of past condom use on subsequent condom use. Reduction of the
14 effect of intention on behavior by past behavior is consistent with other tests of social cognitive models
15 in health behaviors in primary studies and meta-analyses (Hagger & Chatzisarantis, 2016), including
16 research examining condom use (Albarracín et al., 2001). However, the reduction in the size of the
17 effects in the current analysis with the inclusion of past condom use was relatively trivial and not
18 statistically significant. Inclusion of past condom use in the model, however, accounted for a
19 substantive proportion of additional variance in condom use. Importantly, there were statistically
20 significant direct and indirect effects of past condom use on future condom use through the model
21 constructs. According to Ouellette and Wood (1998), direct effects of past behavior on subsequent
22 behavior may model habitual effects, behavioral stability, and represent the non-conscious, automatic
23 processes by which behavior is enacted. Indirect effects through intentions and other social cognitive
24 variables may reflect deliberative, rational decision-making processes. Given that the direct effect was
25 much larger than the indirect effect of past condom use on condom use, current findings suggest that

1 condom use in sub-Saharan African youth has a strong habitual component. One interpretation of this
2 pattern of effects is that the decision to use condoms, or not, is predominantly determined by previous
3 experience and past habits. It also implies that intentional processes might play a less important role. Of
4 course, the significant, non-trivial effects of intentions on condom use mean that effects of intentions
5 are not negligible, and that intervening to change intentions remains a viable prospect. However, the
6 impact of intentions may be weakened in the face of strong habits. In such cases, it may be necessary to
7 use intervention strategies aimed at promoting habitual use of condoms, or means to break habitual non-
8 use. Such strategies may include cue-identification and management, and self-monitoring (Hagger,
9 Luszczynska, et al., 2016). Getting individuals to recognize the potential cues or prompts to unwanted
10 behaviors and manage them is one strategy to circumvent habitual action. Similarly, flagging cues to
11 carry or ensure availability of condoms (e.g., going to a social gathering, visiting a potential partner),
12 and also situations where one is likely to negotiate their use with a prospective partner, and dealing with
13 potential negative responses, may assist in preventing habitual non-use. It is also possible that the direct
14 effect of past behavior on condom use is due to shared method variance between the two behavioral
15 assessments. This may have been a possibility given that condom use was measured exclusively by
16 self-report. However, the time lag between assessments may have mitigated such effects.

17 **Effects of Moderators**

18 Overall, few of the averaged sample-weighted correlations among model constructs were related
19 to the moderators we coded. Results provide little evidence to indicate a systematic pattern of
20 moderation. Heterogeneity in effect sizes was low to moderate in most cases, which may explain why
21 candidate moderators did not substantially impact construct relationships. The only exception to this
22 pattern was the formative research moderator. Six of the 25 effects were stronger in studies that
23 included a formative research component, in relation to studies that did not include formative research.
24 The inclusion of a formative research component may have benefited studies in several respects. For
25 example, formative research in these studies focused on the development and piloting of study

1 measures, particularly ensuring that the content of items is relevant to the sample (e.g., by identifying
2 salient beliefs), and improving the correspondence between the measures and the target behavior. This
3 process is likely to have improved the precision of the study measures and reduced method variance.
4 Consequently, the inclusion of formative research is an important methodological step in developing
5 measures when testing social cognitive models in condom use research in sub-Saharan Africa youth.
6 However, these differences did not translate to variations in effect sizes when testing the full model.
7 Our sensitivity analyses did not indicate any variation in model effects when studies without a
8 formative research component were excluded. Given that the moderator analysis affected relatively few
9 relations the integrated model, it is likely that the moderator effects were insufficiently pervasive to
10 have a substantive effect on the full network of constructs in the proposed model. Overall, these data
11 provide preliminary evidence that excluding studies without a formative research component did not
12 have meaningful effects on model tests, and did not affect conclusions drawn. Still, it is important to
13 acknowledge that we were unable to test the model in a set of studies without a formative component
14 due to insufficient studies testing some of the model relations. This precluded a comparison of models
15 for mutually-exclusive sets of studies that included and did not include a formative research component.

16 **Strengths, Limitations, and Avenues for Future Research**

17 The current study is the first to develop and test an integrated condom use model in sub-Saharan
18 African youth based on a meta-analytic synthesis of studies testing social cognitive models in this
19 context. Our model and research synthesis make a number of important contributions. Consistent with
20 the advocacy of integrated theoretical approaches to provide efficient and comprehensive means to
21 explain behavior (Hagger, Koch, et al., 2017; Hamilton, Kirkpatrick, Rebar, & Hagger, 2017; Montaña
22 & Kasprzyk, 2008), we developed our model by integrated constructs from multiple social cognitive
23 models applied to condom use following McMillan and Conner's (2007) 'core cognitions' framework.
24 This endeavor reduced redundancy across multiple constructs, increased parsimony in predictors, and
25 identified the social cognitive predictors that may be optimally effective in predicting condom use and

1 associated processes. Our analysis also demonstrated the unique effects of the integrated model
2 constructs on condom use intentions and behavior across studies included in the analysis using meta-
3 analytic structural equation modeling. Finally, we tested the effects of a number of candidate
4 moderators of effects among the integrated model constructs.

5 Many of the limitations of the current analysis relate to shortcomings in the included studies.
6 For example, the majority of studies were classified as of ‘questionable’ methodological quality. Still,
7 our moderator analyses indicated that study quality did not systematically influence any of the averaged
8 sample-weighted correlations among model variables. Nevertheless, a separate methodological artifact,
9 the inclusion of formative research, did have an effect on some of the study relations, indicating the
10 importance of developing appropriate measures that are likely to capture constructs of interest with
11 greater precision. A related issue is the relatively small number of studies in some levels of the
12 moderator variables (Table 1). In some cases, moderator groups sample sizes included fewer than five
13 studies, which likely reduces the precision of the estimate and increases the sensitivity of the effect size
14 to errant effects. In addition, in order to estimate the structural equation models, we had to complete
15 two empty cells in the set of correlation matrices with data from primary research on condom use in
16 other contexts. While we took care in filling these cells with data from condom use studies that had
17 sampled closely related populations, current findings should be interpreted with this caveat in mind. As
18 the number of studies in the field increases, future studies may be able to test the model on complete
19 sets of correlation matrices and test effects of moderators with greater accuracy.

20 Although a number of the current studies were prospective in design and reported including a
21 follow-up measure of condom use, a further limitation of the current studies was the preponderance of
22 cross-sectional correlational data. Such data provide no basis on which to infer causal relations among
23 model constructs, and the direction of effects is inferred from theory alone. This means that other
24 statistically plausible models that fit the current data could be found, even if the pattern of effects may
25 be theoretically contraindicated (Hagger & Chatzisarantis, 2016; Hagger, Gucciardi, et al., 2017). We

1 therefore advocate future research that aims to manipulate some of the key predictors of condom use
2 intentions and behavior in sub-Saharan African youth and examine the effects on behavioral outcomes.
3 A further issue is that variation in time lag between measures of the psychological variables and
4 prospectively-measured condom use across studies may also have added additional method variance to
5 the sets of relations. Although we found larger effects with longer time lag for the attitudes-norms,
6 attitudes-intentions, and norms-intentions relations, time lag did not moderate the correlations among
7 the majority of the model constructs. Nevertheless, time lag remains a potential source of variance. As
8 the literature expands, the probability of more studies with a greater variation in lag times increases, so
9 examining time lag as a moderator should be a priority in future analyses. Finally, our model is limited
10 in that it focuses exclusively on social cognitive predictors and an individualist approach. The model is,
11 therefore, silent on other influences such as implicit, relational, societal, and structural factors (Johnson
12 et al., 2010), which have been shown to impact condom use (Protogerou & Hagger, 2017). Related,
13 although we found non-trivial, statistically significant effects among key model constructs, the effects
14 were relatively small. Finally, a substantive proportion of the variance in condom use intentions and
15 behavior remained unexplained. Future theoretical and empirical work should seek to incorporate
16 additional variables into the model and evaluate the extent to which they add to the prediction of
17 condom use in this population.

18 **Conclusion**

19 Our integrated model provides cumulative evidence of a core set of social cognitive
20 determinants of condom use intentions and behavior among sub-Saharan African youth derived from
21 multiple models and theories. The model is the first to demonstrate the key predictors of condom use
22 based on a synthesis of research in this population and context, and to identify salient predictors
23 through a systematic synthesis of constructs and measures across social cognitive models applied in this
24 context. We anticipate that our model may provide a basis for future research examining the predictors,
25 and hope to see further corroboration of the model predictions through primary research. The model

1 may also assist in the development of interventions, particularly those that may assist in breaking habits
2 and facilitating healthy self-regulation. We also expect our findings to inform future research,
3 particularly in relation to the need to conduct formative research in developing measures, and the need
4 for more experimental and intervention research aimed at manipulating key constructs in the model.
5 Finally, we view the model as flexible and modifiable, and we look to future high quality tests of its
6 premises to provide further data on how the model may be modified to improve its predictive validity.

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Table 1
Averaged Sample-Weighted Correlation Coefficients (r_+) and Heterogeneity Statistics for Effects Among Constructs from the Integrated Condom Use Model

Relationship ^a	k	N	r_+	CI_{95}		τ	Q	df	I^2	τ_k
				LL	UL					
Attitudes-Norms	29	26,935	.35	.28	.42	.04	53.82**	28	47.97	-0.19
Attitudes-Control	27	28,135	.31	.20	.42	.10	33.00	26	21.19	0.06
Attitudes-Risk perceptions	16	10,862	.07	-.06	.20	.07	16.35	15	8.26	-0.19
Attitudes-Barriers	7	3,015	.04	-.11	.19	.04	12.54	6	52.16	0.15
Attitudes-Intentions	39	30,408	.38	.31	.45	.06	63.98**	38	40.60	0.03
Attitudes-Condom use	8	3,668	.20	.13	.26	.01	7.78	7	10.04	0.05
Attitudes-Past condom use	30	32,101	.20	.15	.25	.17	36.74	29	21.08	0.13
Norms-Control	28	27,035	.36	.26	.45	.08	38.60	27	30.05	-0.19
Norms-Risk perceptions	7	4,040	.28	.18	.38	.01	7.59	6	20.95	-0.71*
Norms-Barriers	2	302	.17	-.06	.38	.02	1.00	1	0.00	-1.00**
Norms-Intentions	39	30,730	.40	.32	.47	.07	57.84*	38	34.29	-0.05
Norms-Condom use	8	3,668	.21	.14	.28	.01	30.84***	7	8.19	0.28
Norms-Past condom use	27	29,283	.22	.13	.31	.06	20.18	26	0.00	0.10
Control-Risk perceptions	9	6,401	.30	.13	.45	.07	9.95	8	19.58	-0.05
Control-Barriers	2	302	.07	-.04	.18	.00	0.72	1	0.00	-1.00
Control-Intentions	37	30,539	.39	.31	.47	.09	59.71**	36	39.71	-0.25*
Control-Condom use	8	3,668	.17	-.04	.37	.09	6.09	7	0.00	0.57*
Control-Past condom use	34	40,046	.27	.19	.34	.05	32.49	34	0.00	0.09
Risk perceptions-Intentions	17	7,517	.24	.12	.36	.07	17.77	16	9.99	-0.19
Risk perceptions-Condom use ^b	1	1,006	.08	-	-	-	-	-	-	-
Risk perceptions-Past condom use	15	12,472	.05	.00	.10	.01	27.88*	14	49.79	0.07
Barriers-Intentions	5	1,305	.05	-.23	.32	.01	3.27	4	0.00	0.00
Barriers-Past condom use	6	3,041	.03	-.18	.24	.07	8.18	5	38.89	-0.07
Intentions-Condom use	9	3,988	.28	.20	.35	.01	16.83*	8	0.00	0.28
Intentions-Past condom use	15	23,363	.31	.18	.43	.07	20.03	14	30.11	0.10
Condom use-Past condom use	5	2,050	.49	.21	.70	.13	3.84	4	0.00	-0.20

Note. r_+ = Sample-weighted average correlations; k = Number of studies; N = total sample size; CI_{95} = 95% confidence intervals for sample-weighted averaged correlation; LL = Lower limit of 95% confidence interval; UL = Upper limit of 95% confidence interval; τ = Estimated variance in population (Fisher-Transformed correlation); Q = Cochran's (1952) Q homogeneity statistic; df = Degrees of freedom for the Q statistic; I^2 = Higgins and Thompson's (2002) I^2 statistic; τ_k = Begg and Mazumdar's (1994) ranked correlation statistic based on Kendall's τ . ^aEffect sizes for the relationships between risk perceptions and barriers and between barriers and condom use are omitted as no studies in the current sample tested these effects; ^bOnly one study in the current sample provided a test of the relationship between risk perceptions and condom use which precluded a meta-analytic synthesis, the reported effect size is raw effect size reported in the study. * $p < .05$ ** $p < .01$ *** $p < .001$

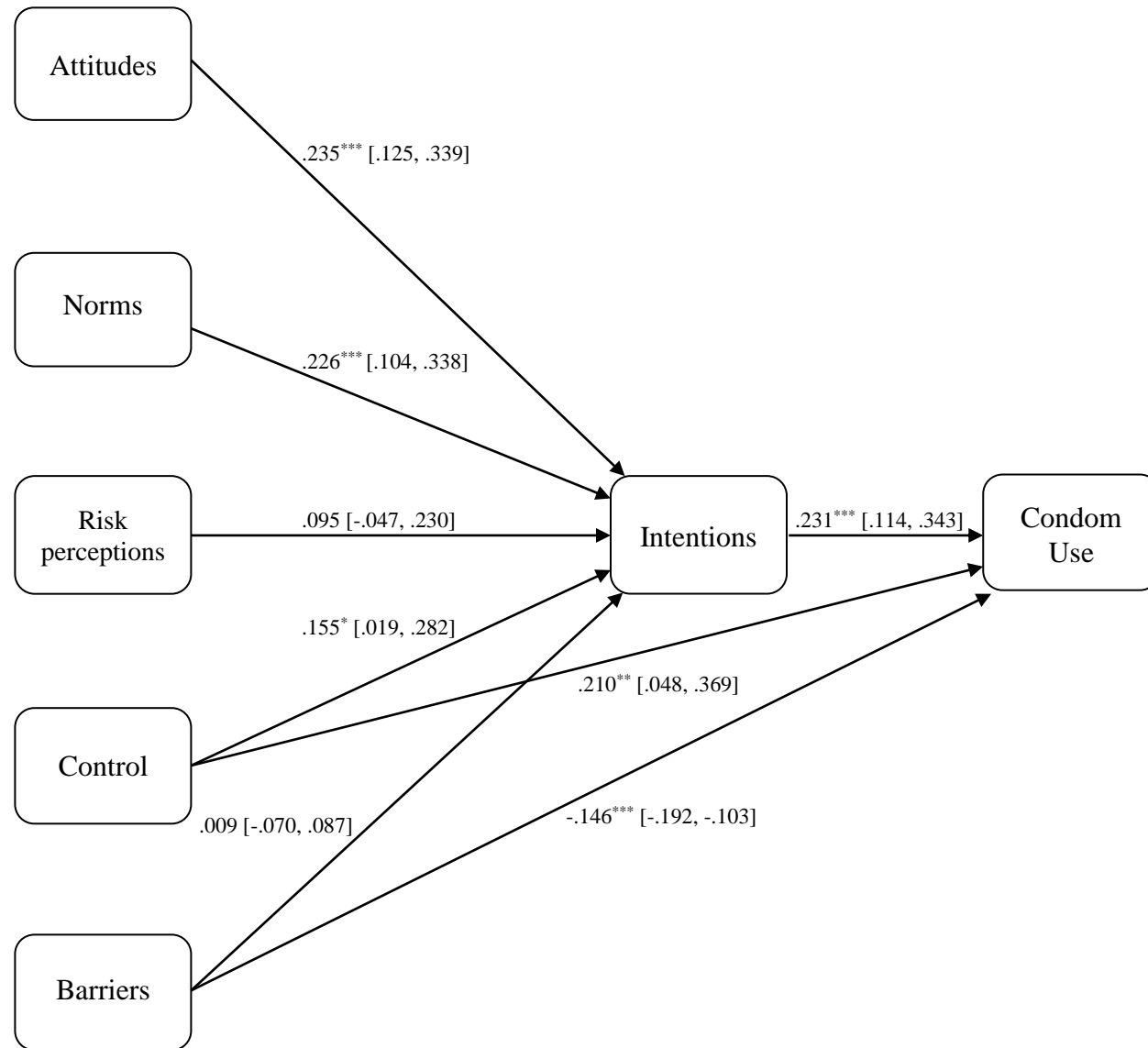


Figure 1. Path diagram of the integrated condom-use model. Coefficients are standardized parameter estimates (β) with likelihood-based 95% confidence intervals in parentheses. Effects omitted from model for clarity: total effect, control \rightarrow condom use, $\beta = .246$ [.096, .394]; total effect, barriers \rightarrow condom use, $\beta = -.144$ [-.192, -.099]. $^{***} p < .001$ $^{**} p < .01$ $^* p < .05$

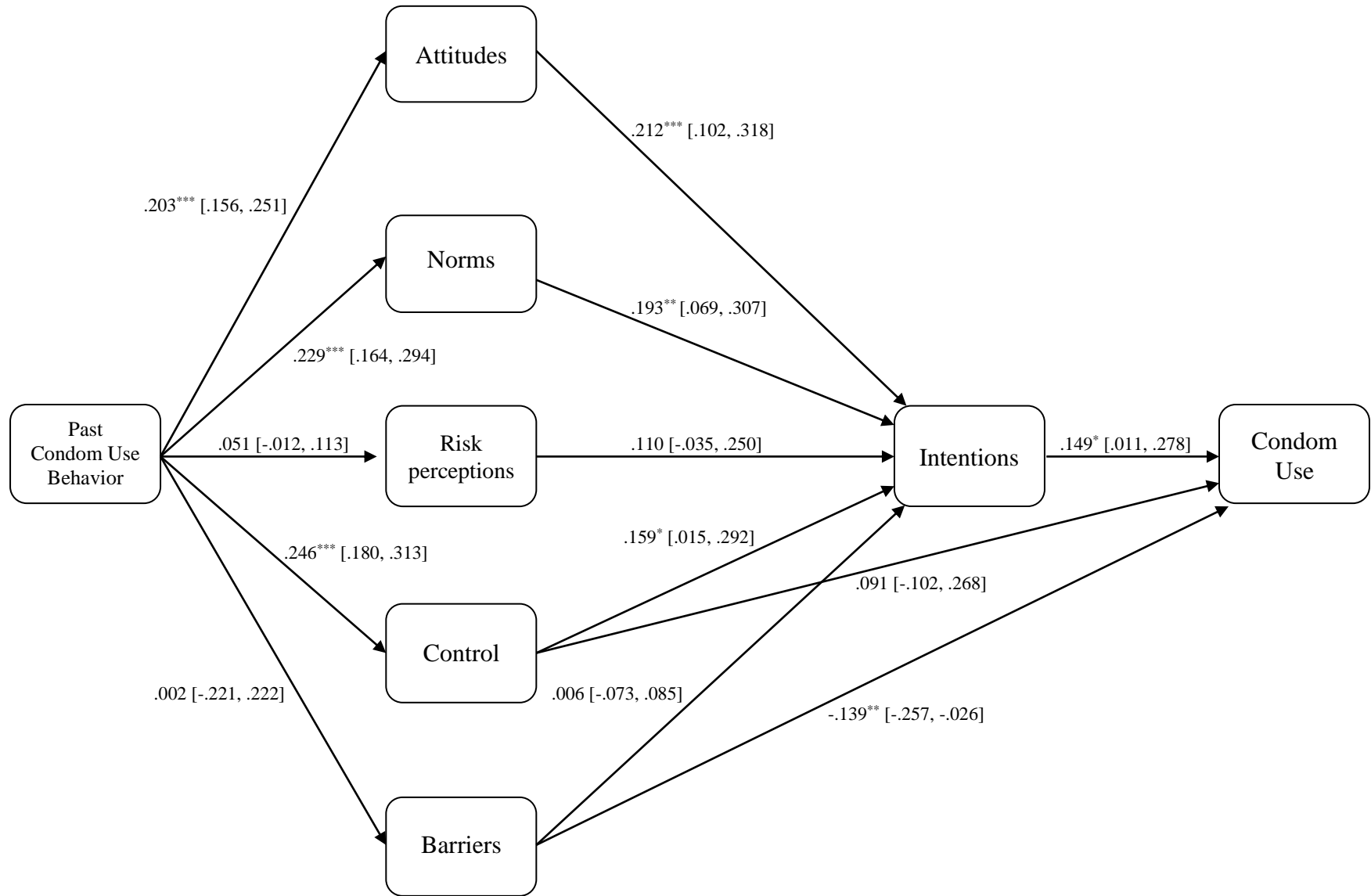
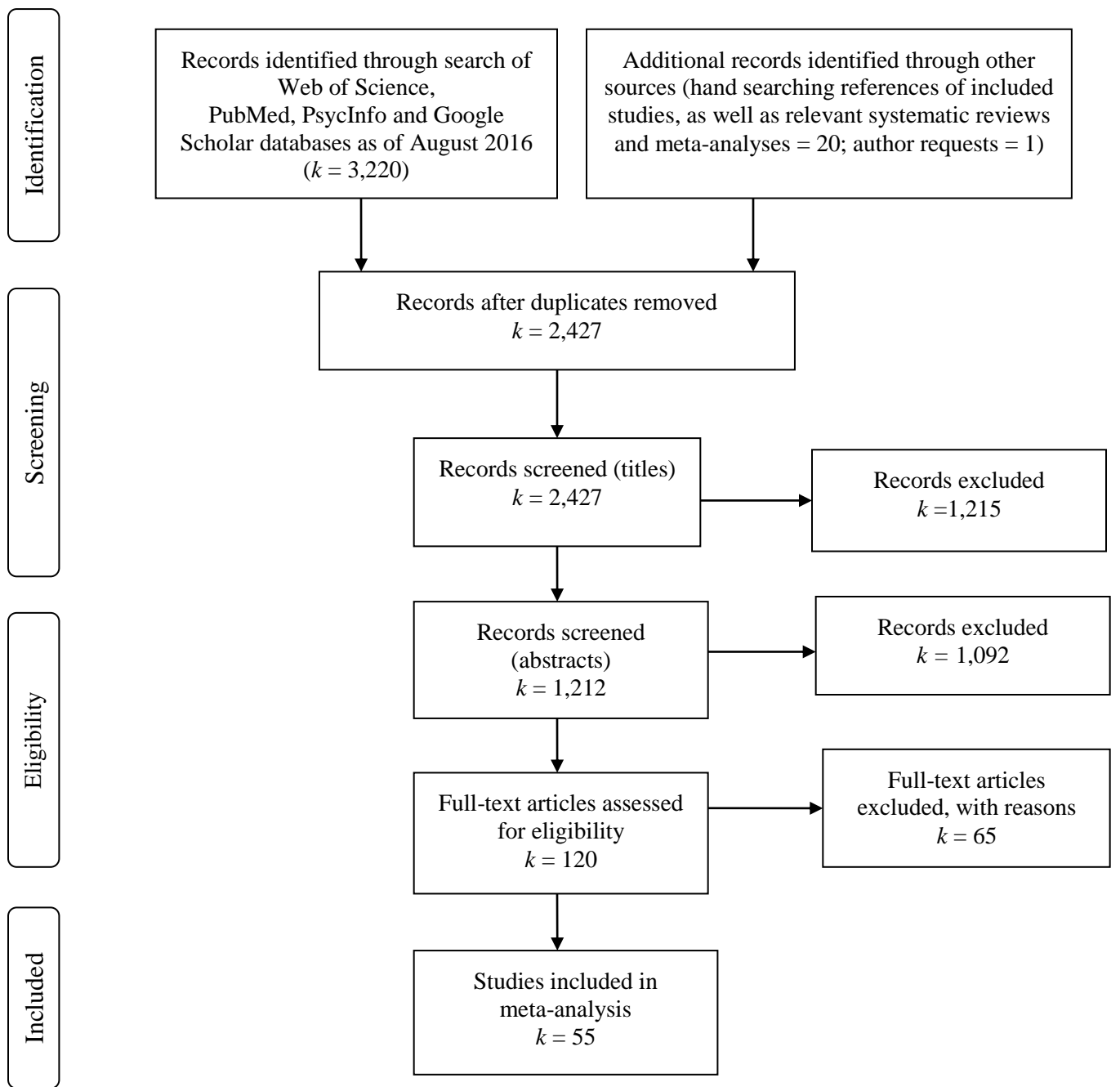


Figure 2. Path diagram of the integrated condom-use model including effects of past condom use. Coefficients are standardized parameter estimates (β) with likelihood-based 95% confidence intervals in parentheses. Effects omitted from model for clarity: total effect, control \rightarrow condom use, $\beta = .115 [-.061, .280]$; total effect, barriers \rightarrow condom use, $\beta = -.138 [-.252, -.022]$; direct effect, past condom use \rightarrow condom use, $\beta = .433 [.225, .639]$; total effect, past condom use \rightarrow condom use, $\beta = .510 [.306, .714]$.

*** $p < .001$ ** $p < .01$ * $p < .05$.



Reasons for excluding studies: (1) outcome variable was not condom use; (2) composite outcome variable that included a parameter of condom use (e.g., averages of condom use and illegal substance use); (3) duplicate version of an original study (e.g., abstract-only report, conference presentation); and (4) a qualitative design, government report, or editorial/opinion piece.

Figure 3. Flow of studies through meta-analysis based on PRISMA guideline