**Running Head: ADOLESCENT LIFE SKILLS REVIEW**

**Implementation and effectiveness of adolescent life skills programs on in low- and middle-income countries: A critical review and meta-analysis**

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**SUMMARY**

**Background.** Adolescence represents an unprecedented opportunity to invest in health. Individual adolescent life skills programs in low- and middle-income countries (LMICs) have demonstrated success but neither their relative effectiveness across multiple health arenas, including mental health, nor their key ingredients have been examined.

**Methods.** We conducted a systematic review and meta-analysis to identify key implementation processes and effectiveness of life skills programs among adolescents in LMICs which targeted at least one mental health outcome, as well as their relative effectiveness. Six academic databases, including PubMed and PsychInfo and bibliographies of related reviews, were systematically searched until July 1, 2016, with no restrictions on language or publication year. Studies were excluded if they were conducted in HIC settings, among chronically ill populations or lacking adolescents aged 10-19 years. Data from published reports related to the characteristics of RCTs and their implementation processes related to ‘who, what, how and where’ were extracted, including the development of a taxonomy to determine which life skills constituted each program. Meta-analyses with random effects models examined the overall trial effectiveness, as determined by their primary outcomes. Subsequent exploratory analyses determined which implementation processes predicted trial effectiveness (PROSPERO CRD42016043448).

**Results.** We included 50 eligible RCTs from 45 articles with a focus on an adolescent health program, which targeted at least one or more mental health outcomes. Most of the RCTs, conducted across 19 LMICs, targeted students (82%) and refugees (7%), and both genders (71%). Most of the interventions were delivered by teachers (n=12), and specialist providers (n=11), and most were focused on high-risk groups rather than clinically-disordered populations. These interventions were effective in reducing symptoms of anger (SMD=1.234), improving life skills (SMD=0.755) and functioning (SMD=0.491), and decreasing PTSD (SMD=0.327), depression and anxiety (SMD=0.305). Trial effectiveness was positively associated with the following life skills: interventions focused on parent-child interactions (β=0.557, p<0.05), assessing interpersonal relations (β=0.204, p<0.05) and stress management (β= 0.216, p<0.05).

**Discussion**. Our results demonstrate the benefits of life skills programs targeting one or more mental health outcomes and co-occurring risk factors in school and community settings. Comprehensive programs focusing on multiple life skills related to the individual, his or her social environment and, in particular, interventions promoting parent-child interactions may hold particular promise in LMICs to address the burden of poor mental health and other health arenas.

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**INTRODUCTION**

Adolescence, aged 10 to 19, encompasses a critical period that fosters or hinders psychological, physical and sexual and reproductive health (Patton et al., 2016). This is particularly relevant in low- and middle-income countries (LMICs; Kieling et al., 2011), where adolescents comprise up to 25% of the population (Kyu et al., 2016), are particularly susceptible to multiple co-occurring risk factors and recognized as a conduit for maternal and child health (Asarnow & Miranda, 2014; Kyu et al., 2016). Moreover, because many health behaviors that contribute to morbidity and mortality are established during adolescence (Asarnow & Miranda, 2014; Campo, 2012; Kieling et al., 2011), this period is recognized as a critical time to introduce and sustain critical health-related knowledge and skills—particularly for areas related to mental health (Pandey et al., 2018).

Defined broadly, life skills are adaptive and positive behaviors that enable individuals to deal effectively with the demands and challenges of everyday life (UNICEF, 2012). Life skills interventions have been effective in targeting multifaceted arenas of adolescent health including psychosocial, physical as well as sexual and reproductive health outcomes (DiCenso, Guyatt, Willan, & Griffith, 2002; Durlak, Weissberg, & Pachan, 2010; Horowitz & Garber, 2006). Evidence supports multicomponent interventions which aim to strengthen ‘life skills’ including emotional regulation, self-efficacy and conflict resolution that are typically delivered through a classroom-based curriculum (Durlak, Weissberg, Dymnicki, Taylor, & Schellinger, 2011; Kågesten, Pandey et al., 2008; Parekh, Tunçalp, Turke, & Blum, 2014; UNICEF, 2012; Weare & Nind, 2011); thus, life skills programs overlap with other behavior change programs including psychological treatments, interventions promoting parent child interactions, health promotion strategies and general self-care. To our knowledge, there is no current systematic review and meta-analysis examining the underlying implementation processes of adolescent health programs, including which ‘life skills’ are utilized (Durlak et al., 2011) to effectively address the growing concern of adolescent mental health issues (Patton et al., 2016). This information is critical because it could be used to inform the development of current and future programs to target the interlinked health needs of adolescents worldwide.

The purpose of the current study was to conduct a systematic review and meta-analyses to examine which life-skills have been implemented in LMIC and which, if any, influence the effectiveness of adolescent health programs. Our central questions are:

1. What are the relevant implementation processes of adolescent life skills programs in LMICs?
2. What is the relative effectiveness of adolescent life skills programs on mental health outcomes and other listed primary outcomes?
3. What ‘life skills’ have been implemented in these adolescent health programs? And which life skills relate to trial effectiveness?

**METHODS**

**Eligibility Criteria**

We aimed to include all RCTs that evaluated adolescent life skills programs that included at least one mental health outcome in a LMIC setting. Our four inclusion criteria were: i) studies in LMIC as defined by The World Bank (2016) ; ii) a primary target of adolescents, ages 10 to 19 (World Health Organization, 2017) ; iii) a programmatic focus on adolescent life skills—defined broadly as psychosocial and interpersonal skills fostering adaptive and positive behavior that enable adolescents to deal effectively with the demands of life (UNICEF, 2012) —and iv) measuring one or more mental health outcomes, as broadly defined by Barry and colleagues (2013) and iv) involved a randomised controlled trial design. Our exclusion criteria were: i) Health programs focused on chronically-ill adolescents or specialized populations (e.g., orphans); and ii) books, conference papers, theses, reviews and articles without available full text (i.e., conference, editorial, author response).

**Search Strategy**

We conducted a systematic review and meta-analysis in accordance with PRISMA guidelines (Moher, Liberati, Tetzlaff, & Altman, 2009). The protocol was developed following the procedures outlined in the Cochrane handbook for systematic reviews (Higgins et al.2011) and registered (PROSPERO CRD42016043448). We conducted a systematic review using a modified search strategy combining those from previous reviews focusing on comprehensive health programs (Kågesten et al., 2014) and mental health promotion (Barry et al., 2013) for adolescents (see Table 1 for our search strategy). Six academic databases, including PubMed, PsychInfo, Clarivate analytics Web of Science, WHO Global Health Library (GHL) and Virtual Health Library (VHL) were systematically searched until July 1, 2016, with no restrictions related to language or publication year. We also utilized reference lists from previous reviews including adolescent mental health and psychosocial well-being (Barry et al., 2013; Das et al., 2016), sexual education and reproductive health (Haberland & Rogow, 2015; Kirby, Laris, & Rolleri, 2007) and comprehensive programs involving more than one target area (Kågesten et al., 2014; Mason et al., 2014). After the full text screening, bibliographies of full texts included in the review were searched to identify relevant studies.

**[INSERT TABLE 1]**

**Development of Life Skills Taxonomy**

The development of the current life skills taxonomy followed the procedures outlined previously (Singla et al., 2017), with a particular focus on children and adolescents aged 10 to 19. Specifically, our team compiled a list of all relevant life skills and health behavior change techniques from several taxonomies (Brown, de Graaff, Annan, & Betancourt, 2017; Michie, Van Stralen, & West, 2011; Murray et al., 2014; Practicewise, 2015; Singla et al., 2017), whereby life skills were defined as any skill introduced to the target participant which translated into adaptive and positive behaviors (UNICEF, 2012). These elements were reviewed for redundancy and relevance and each life skill was operationalized (see Supplementary Table 1). The taxonomy was then piloted through three rounds of coding and then modified based on group discussions among authors. The taxonomy was then sent to several experts and finalized with the team. A final round of testing the taxonomy took place to test the reliability of the taxonomy and we found excellent inter-rater reliability between four independent researchers (ICC=0.862). The final taxonomy resulted in a total of 16 life skills across four subcategories: behavioral, interpersonal, cognitive and parental (See Figure 2 for details). We differentiated parental from interpersonal to differentiate those programs which explicitly involved parents.

**Data Extraction and Management**

In addition to the life skills taxonomy, four independent researchers extracted information regarding implementation processes related to program setting, target population, format of program (e.g., individual vs. group), theoretical orientation, type and training of delivery agent, and main findings based on the primary endpoint. Information was collected from primary trial papers as well as linked articles which included trial protocols, treatment development articles, or secondary analyses and were utilized to supplement the primary trial article descriptions (see Table 1). For the meta-analysis, we extracted the means and standard deviations of primary endpoints for both the intervention and control arms, and their respective sample sizes.

**Outcome Measures**

We used the primary outcome identified in each study when stated. An effect size was calculated for each listed primary outcome, using means and standard deviations to estimate a standardized mean difference (SMD). If means and standard deviation were not reported for the outcomes of interest, we extracted related binary data and unadjusted statistical effect sizes. Using previously-recommended assumptions and formulae (Chinn, 2000), these binary outcomes were transformed to SMD, based on the assumption that a) continuous measurements follow a logistic distribution and b) the variability of the outcomes is the same in both intervention and control groups (Higgins et al., 2011). When multiple control groups were available, the active control group data was prioritized for extraction; however, this was limited to only five of the 50 trials in the current dataset. Finally, when studies provided data for more than one endpoint, we used the specified primary acute treatment end point. When no end point was specified, we used the time point that immediately followed the end of treatment in the active intervention group.

**[INSERT TABLE 2]**

**Assessment of risk of bias**

Two authors independently assessed the eligible trials for risk of bias using Cochrane’s risk assessment tool against seven matrices including random sequence generation, allocation concealment, selective reporting, blinding of research personnel and participants, blinding of outcome assessors, attrition bias and other biases (Higgins et al., 2011). All discrepancies in risk assessment were resolved and finalized through discussion and mediation by a third author. Studies meeting three of more high-risk criteria were considered as low quality according to criteria (Cuijpers et al., 2014).

**Analysis**

We estimated the frequencies of all implementation processes, including the number of life skills listed in each study. For these implementation processes, all frequencies are represented by a total or percentage where the denominator is the total N of eligible trials (N=45), unless otherwise indicated (e.g., if data were not specified or missing for a particular variable). Where possible, the mean was calculated along with the 95% confidence interval (CI). Where ranges were provided for a particular trial (e.g., 6 to 10 sessions), the average was used (8 sessions).

For the meta-analyses, we utilized all primary outcome data available for each trial.

Analyses were carried out with the Comprehensive Meta-analysis software 2.1. This program accepts data in more than 100 formats, and thus, provides a convenient platform for meta-analyzing outcomes reported in different formats. A series of meta-analyses were run to pool studies reporting similar outcomes, thus, estimating aggregate means, weighted by participant numbers. These meta-analyses were represented as forest plots of SMDs, their 95% confidence interval and relative weights calculated as inverse of its variance and accounting for both original with-in studies variance and between studies variance Tau (Borenstein, Hedges, & Rothstein, 2008). We employed a random-effects analysis (DerSimonian & Laird, 1986) because of expected heterogeneity, including the presence of cluster randomized trials for which random-effects models are the method of choice. Heterogeneity among trials was calculated using the Q statistics and *I2* measure of inconsistency which describes the percentage of variability in the effect estimates accounting for heterogeneity beyond sampling error (DerSimonian & Laird, 1986; Higgins et al., 2011); where *p*=0.10 and/or *I*2>50% indicate significant heterogeneity. We also conducted post-hoc subgroup analyses using leave-one-out analyses to test the impact of exclusion of a single trial with a disproportionately large effect. Next, we evaluated publication bias by eye balling the Begg’s funnel plot and implementing an Egger’s regression test with a two-tailed p-value (*p*<0.10) is considered significant where there are 10 or more studies to ensure reliability (Egger, Smith, Schneider, & Minder, 1997; Terrin, Schmid, Lau, & Olkin, 2003). Thereafter, outcomes presenting with significant publication bias, we used the trim and fill method (Duval & Tweedie, 2000), to enhance the symmetry of the funnel plot, hence, yielding an adjusted pooled effect size and its 95% confidence interval. Meta-regression for moderators (age, percentage of females, primary time-point, quality of the study, status of a priori power analysis and sample size) were conducted among outcomes with 10 or more trials to examine the potential effects on the pooled effect sizes. Moreover, subgroup analyses were conducted to examine the potential influence of geographical location, type of prevention/treatment and setting of the intervention (Fu et al., 2011). In case of substantial heterogeneity in reporting of outcomes, it was explored using meta-regression for quantitative moderators and I2 and Tau2 values were explored for a variety qualitative groups of studies (Higgins & Thompson, 2002).

Finally, we conducted exploratory analyses of the predictive effects of specific life skills on trial effectiveness. For these analyses, we selected only one outcome estimate for each trial, prioritizing the continuous outcome defined as primary by the authors to estimate the ES (n=45). Variance inflation factor (VIF) was conducted for each model to assess multicollinearity between independent variables, with a conservative estimate (VIF≥5). All quantitative analyses were estimated using SAS 9.4.

**RESULTS**

In total, our search yielded N=50 eligible trials among 45 articles (see Figure 1), all of which were published in English. Among these, 42 were individually randomized controlled trials and 8 were cluster randomized controlled trials. Trial participants were typically recruited from their schools (n=33), followed by primary care settings (n=6), refugee clinics (n=4), community settings (n=4), and home (n=2). Home-based recruitment typically took place in refugee camps or communities in which house-to-house screening was used to identify potential participants.

**[INSERT FIGURE 1 AND TABLE 2]**

**Risk of Assessment.** Our assessment to estimate the risk of bias demonstrated an overall low risk of bias in 27 (60%) of the studies as compared to 18 (40%) studies reporting a high risk of bias (see Supplemental Figure 1). A higher proportion of studies revealed risk of bias in blinding of research personnel and participants (n=8, 17.8%) and outcome assessors (n=17, 37.8%) while low risk of bias was associated with random sequence generation (n=23, 51.1%), allocation concealment (n=25, 55.6%) and attrition bias (n=29, 64.4%) in included studies. In a majority of studies, criteria of selective reporting (n=35, 77.8%) and other risks of bias (n=21, 46.7%) could not be allocated to either high or low risk of bias due to a number of published trials without any published study protocols or *a priori* proposals (see Supplementary Table 2).

**WHERE: The program setting**

The studies were conducted across 19 LMICs, most commonly in China (n=9), Uganda (n=8), Iran (n=6), and India (n=6). Among the trials that specified the type of geographical region (n=40), 40% of the trials took place in rural settings, with the remainder equally distributed in urban (30%) and mixed (30%). The wide majority of programs (n=45) took place in schools (78%), followed by community settings (10%), refugee camps (8%) and participants’ homes (4%).

WHAT: The program ingredients

We examined life skills in the primary treatment arm, resulting in a total of 45 trials. Among these (Figure 2), the most commonly reported life skills were communication skills (57.8%), problem-solving (53.3%), assessing relations (51.1%), stress management (44.4%), emotional regulation (44.4%), identifying/eliciting affect (37.8%), self awareness (35.6%) and exposure (26.7%) or interventions promoting parent-child interactions (26.7%). The life skills that were the least reported were self-talk (13.3%), meditation/mindfulness (8.9%), decision-making skills (8.9%), psychoeducation for parents (8.9%), and caregiver coping (i.e., skills for parents to cope with parental stress; 4.4%). Following the final round of pilot testing of the taxonomy, no additional skills were suggested by data extractors. Behavioral-based skills were the most commonly endorsed subgroup (93.3%), followed by interpersonal (86.7%), cognitive (66.7%), and parent-child interaction skills (24.4%). Only 3 programs (6.7%) explicitly including a component on substance use. Among the 45 trials, the majority (60.0%) were targeted programs, which typically focused on a subgroup of high-risk individuals meeting a particular threshold of depressive, anxiety or traumatic symptoms.

**[INSERT FIGURE 2]**

Among those who reported a theoretical orientation (n=31), the most commonly-endorsed was cognitive and/or behavioral (54.8%). followed by social-cognitive learning theory (25.8%), psychosocial and motivational interviewing (6.5%) and interpersonal or mindfulness (3.2% each).

WHO: The target population and delivery agents

The average age of participants was 15.25 years (95% CI=14.2 to 16.3), with the wide majority of programs focusing on middle to late adolescents (95.6%). The target population in most trials involved school children (77%), followed by torture survivors (7.7%), refugees (5.0%) and primary care attendees (2%). Most trials (62.9%) targeted both adolescent boys and girls (71%), followed by only girls (17%) and boys (12%).

Among those trials that reported ‘who’ delivered the program (n=43), the most common delivery agent were teachers employed in existing schools (34.8%). The other frequently-endorsed personnel included a health specialist or researcher (25.6%), peers (20.9%), nurse or lay counsellor or community member (7.0% each), and social worker or community health worker (2.3% each). Selection criteria for a particular delivery agent typically reflected his or her educational background (n=17) and language proficiency (n=18). The education background reported was post-graduate (70.6%), secondary school (17.6%) and primary school (11.8%). Language proficiency typically reflected being bilingual whereby 27.8% trials (n=5) reported that the delivery agent was selected because of his/her ability to communicate in the local language to the participants and that of training (typically English). Few trials (*n*=5) reported on the gender of the delivery agent; of these, all involved females.

Mental health specialists played diverse roles in these treatments, most commonly in trial evaluation (100%) followed by training and supervision of delivery agents (35.6% and 40.0% respectively) and receiving or sending referrals (8.9%). In addition, mental health specialists and non-mental health specialists (individuals with no formal training in mental health) were equally distributed as delivery agents of the 10 prevention programs (χ²=0.885, *p*=0.645). In contrast, trials based in middle income countries, i.e., China, were significantly more likely to be implemented by a specialist than a non-specialist delivery agent (χ²=5.467, *p*=0.019).

HOW: The program delivery

Training methods were reported in 23 trials. Most programs (65.2%) used a mixed-methods approach to train delivery agents while others reported only using practice (21.7%) or only didactics (6.7%). This mixed approach typically involved an intensive period of didactics, led by a trainer in face-to-face format, to learn about the program and/or counselling skills which was followed by the opportunity to practice skills through role plays with other delivery agents and/or with existing participants during a pilot phase. Approximately half (n=23 trials) specified the duration of their training methods which ranged from two hours to 3.5 months. On average, training lasted 107 hours (roughly two weeks). Only eight trials reported conducting a formal evaluation to examine the competency levels of delivery agents and three studies reported providing certification. Only 13 trials reported compensation packages for delivery agents which typically involved either providing a per diem or reimbursement for relevant costs such as travel; in three trials, the delivery agent role was voluntary.

Nine trials reported the ongoing monitoring and supervision of delivery agents. Of these, one-third reported conducting supervision in-person, one-third over the telephone and one online via skype support. Much of supervision was conducted individually (55.6%) or in groups individually (44.4%). These methods were reported in nine trials and typically involved discussing a particular case (44.4%), listening to an individual session via audio (33.3%), or observing a session (22.2%). Seventeen trials reported who and how often supervision was conducted. Supervision was typically conducted on a weekly basis (67.9%); in the remainder, supervision was conducted ad-hoc when required (22.2%) or monthly (11.1%) basis.

Most reported using a manualized program (53.3%), with a specific sequence for sessions (53.3%) and three studies (6.7%) reported using booster sessions. All trials delivered their program in-person; four (8.9%) also used the telephone. Overall, program duration (n=36) was 13.5 weeks (95% CI=8.4 to 18.6). 38 trials (84.4%) reported on the mean number of intended meetings, which was 10.1 (95% CI=8.6 to 11.7) contacts over 73.3 minutes (95% CI=65.1 to 81.5) per interaction.

HOW EFFECTIVE: Meta-analyses of program effects

Life skills programs targeted a wide variety of primary outcomes (Figure 3), including: the enhancement of life skills (n=10), self-esteem/efficacy (n=6), and functional health (n=4); and the reduction of trauma symptoms (n=9), depressive symptoms (n=6) and physical impairment (n=4). Meta-analysis with random effects model demonstrated a significant improvement in life skills (SMD=0.48, 95% CI=0.27 to 0.69, I2= 88.22%). These interventions also reported a significant reduction in individual outcomes pertaining to mental health symptoms including anxiety (SMD= 0.48, 95% CI=0.18 to 0.77, I2= 0%), depressive symptoms (SMD= 0.24, 95% CI=-0.05 to 0.44, I2= 86.31%) and PTSD symptoms (SMD= 0.60, 95% CI= 0.32 to 0.88, I2= 87.36%), as well as functional impairment (SMD= 0.88, 95% CI=-0.20 to 1.57, I2= 95.39%) and aggression (SMD=1.63, 95% CI= 0.65 to 2.60, I2= 82.68%). Similarly, our meta-analyses reported significant improvements in positive outcomes pertaining to health knowledge of participants (SMD=0.12, 95% CI= 0.01 to 0.34, I2= 86.94%), physical health (SMD=0.56, 95% CI=0.10 to 0.57, I2= 94.33%), self-esteem/efficacy (SMD=0.42, 95% CI=-0.01 to 0.85 I2= 96.03%). Assessment of funnel plot (Egger et al., 1997; Terrin et al., 2003) and Egger’s regression statistic (*t*= 0.71, *df*=10, *p*=0.49) revealed no publication bias in reporting of life skills, depression (*p*=0.52), functionality (*p*=0.12), physical health (*p*=0.54) and self-esteem (*p*=0.54). However, it was evident in reporting of trauma in literature (Egger’s regression *p*=0.01). Duwall & Tweedie’s (2000) trim and fill method was used to yield adjusted effect size for trauma SMD= 0.70 (0.38 to 1.01).

Sensitivity analyses involving leave-one-out approach did not reveal any significant changes in significance of these outcomes except for health knowledge and self-esteem/efficacy which resulted in non-significant findings when specific studies (Kaveh, Hesampour, Ghahremani, & Tabatabaee, 2014; Leventhal et al., 2016; Leventhal et al., 2015; Li t al., 2008; Moshki, Amiri & Khosravan, 2012) were removed separately.

**[INSERT FIGURE 3]**

**Effect of moderators and publication bias in reporting of outcomes**

Subgroup analyses were conducted to examine the potential influence of geographical location, type of prevention/treatment and setting of the intervention (see Supplementary Figure 2). Overall, subgroup analyses demonstrated significantly higher functionality scores among RCTs conducted in Asia vs. Africa; significantly higher health knowledge scores, self-esteem and life skills in prevention compared to treatment-focused interventions but the opposite pattern (treatment over prevention interventions) was favourable for trauma outcomes.

To identify potential sources of heterogeneity, I2 and Tau2 values for each subgroup were compared. The majority of heterogeneity was within subgroups (i.e., the high >80% I2 was within each subgroup) rather than explained by differences between groups. The one exception to this was that school-based studies had lower heterogeneity as subgroups of the trauma and life-skills analyses (I2 = 47.56, n=7 and 53.35%, n=10 respectively). Moreover, notable differences in heterogeneity were noted among different quality of interventions for a number of outcomes including self-esteem, life-skills, and functionality. Both subgroups of treatment and prevention interventions were based on varied life skills, and hence, exhibited a high heterogeneity. However, treatment interventions for outcomes pertaining to functionality exhibited no heterogeneity (0%) while preventive interventions (I2=68.09%). focusing on traumatic symptoms had substantially lower heterogeneity than its counterpart (I2=85.56%). These results are specified in Supplementary Table 2.

Meta-regression for moderators (age, percentage of females, primary time-point, quality of the study, status of a priori power analysis and sample size) were conducted among outcomes with 10 or more trials to examine the potential effects on the pooled effect sizes. As expected for life-skills, meta-regression analysis showed that studies reporting outcomes at later primary time points reported weaker effect sizes than earlier ones (*p*<0.001). However, it yielded no significant associations with gender of participants (*p*=0.10) and mean age (*p*=0.15), when one study was removed from the analysis (Ager et al., 2011). Efficacy of interventions decreased with increasing sample sizes (*p*=0.003). For outcome of trauma, meta-regression analysis revealed no association of efficacy of intervention with time point (*p*=0.320) and publication year (*p*=0.520). Efficacy of intervention decreased with increasing proportion of female participants in an RCT (*p*=0.005). Similar trends were noted showing decreased effect sizes with increasing sample size (*p*<0.001).

**The exploratory link between program elements and trial effectiveness.** No one life skills domain (cognitive, behavioural, interpersonal or parental involvement) was significantly related to trial effectiveness. Consequently, we developed and analyzed a model where we examined the effects of individual life skills on trial effectiveness. Our results (Figure 4) demonstrate a significant model (*F*=4.88, *p*<0.01) which accounted for 26.3% of the variance in trial effectiveness. Using backwards stepwise modelling, three skills influenced trial effectiveness: parent-child interactions, stress management and evaluating interpersonal relations—indicating the benefit of focusing on multiple areas related to the adolescent’s relationship with self, peers and parents.

**[INSERT FIGURE 4]**

**DISCUSSION**

The overarching objective of this review was to generate evidence to inform the development and implementation of adolescent life skills programs in LMIC. The contributions of this systematic review involved describing and evaluating relevant life skills of effective and ineffective adolescent health programs which also targeted mental health symptoms in LMIC contexts. Our results parallel recent and previous results, suggesting the reliable effectiveness of adolescent life skills programs as well as interventions targeting mental health outcomes, particularly in school settings [e.g., (Durlak et al., 2011; Durlak & Wells, 1997; Fazel, Patel, Thomas, & Tol, 2014; Weisz, McCarty, & Valeri, 2006)]. To our knowledge, this is the first meta-analysis examining the relative effectiveness of adolescent life skills programs targeting mental health in LMICs—demonstrating small to medium effect sizes for mental health outcomes and large effect sizes for relevant life skills. This suggests an optimistic opportunity to address the growing burden of adolescent mental health and their co-occurring risk factors in LMICs (Mason et al., 2014). Furthermore, our results add to this literature by highlighting key ingredients of successful adolescent health programs in LMIC which parallel many key or ‘common’ elements of other mental health interventions [e.g., (Brown et al., 2017; Das et al., 2016; Durlak & Wells, 1997)] as well as health behavior change programs more generally (Michie et al., 2011).

Our study suggests that the trial effectiveness of life skills programs reflects three key relationships: the adolescent’s relationship with him/herself (i.e., stress management skills), his or her relations with others, notably peers (interpersonal skills) and parental-child relations (parent child communication skills). Skills reflecting parent-child relations were the least endorsed life skills subgroup but had the most relative influence of all life skills on trial effectiveness. Given the long-term impact of life skills on the life course, the multifaceted and influential role of parent-child interactions on the mechanisms and risk factors related to adolescent health and well-being (Brown et al., 2017; Repetti, Taylor & Seeman, 2002), and recent evidence demonstrating the role of adolescent family relations on long-term adult well-being our findings highlight the critical importance of including parents to enhance the overall effectiveness of life skill programs (Berg, Kiviruusu, Karvonen, Rahkonen, & Huurre, 2017; Fulu et al., 2017). A recent systematic review in HICs highlights the importance of parental involvement in depression interventions for adolescents (Dardas, van de water & Simmons, 2018), and our results suggest the benefits of targeting the interactions between parents and children to influence effect sizes across a wife arena of health outcomes including mental health, life skills, and self-esteem. Furthermore, a focus on integrated care—preventing and addressing mental health within a wider community— may be especially relevant in LMICs where parents and other community agents are often gatekeepers (Salam, Das, Lassi, & Bhutta, 2016). Finally, there was substantial heterogeneity in estimated treatment effects which is understandable given the wide variation in the therapeutic content of the interventions, the number of therapy sessions, and training and supervision practices across the studies.

Our study also highlights important gaps in the existing literature. First, most programs targeted both boys and girls simultaneously; however, it was not clear however whether curricula were gender-sensitive which may be important to target relevant risk factors of maternal and child health (e.g., intimate partner violence and involvement of father in parental care; Chandra-Mouli et al., 2015) and substance use. Gender-sensitive criteria may especially impactful in LMICs where patriarchal norms may be prevalent and there is a unique opportunity to prepare both boys and girls to modify their attitudes early on during this preconception phase (Mason et al., 2014; Salam et al., 2016). Second, the role of adolescents in program development was lacking. Involving adolescents through youth-led participatory action research could promote important development opportunities, leadership skills and positive attitudes among the target group. Third, and similar to others (Brown et al., 2017; Singla et al., 2017), information related to the ‘how’ of the program—e.g., processes related to training, supervision and compensation of delivery agents, and relevant barriers or facilitators—were not commonly reported. While our meta-analysis demonstrated that the wide majority of programs were effective—few to none examined process indicators of preference and likeability—which are known to promote the program’s long-term sustainability (Craig et al., 2008). In order to improve the overall quality of program implementation, it is suggested that all future adolescent health programs follow a similar criterion to report all relevant characteristics as suggested in other studies (e.g., see checklist in Singla et al., 2017). Finally, given the importance of parent-child interactions in adolescent interventions, more research is required to determine how this element could be best utilized in LMICs specifically.

**Limitations**. Our results must be interpreted with caution because unlike other studies using similar methods (Singla et al., 2017), we did not ask authors to rate individual studies for specific skills; therefore, missing information from published articles may not fully represent the role of specific life skills on trial effectiveness. Moreover, it provides a quantitative synthesis of low to moderate quality, with a high percentage of included studies presenting a high risk of bias. Furthermore, we did not assess the degree to which a particular element was implemented in a study—thus, the quality and strength with which these elements were delivered was not assessed. In addition, the wide majority of interventions took place in schools—therefore targeting school-going adolescents. Finally, as mentioned, active control groups were used in our data extraction. While limited in number (n=3 of all eligible studies), we acknowledge that this may have led to a more conservative estimate of our effects.

Future research is required to determine the consistency of our proposed taxonomy and examine the degree and quality with which these elements are delivered in comprehensive, as well as targeted programs. Future research should also consider the examination of middle childhood as a potential target group (as early as 8 to 10 years), as well as non-school-going adolescents to assess other mechanisms of integration beyond schools (Mason et al., 2014; Patton et al., 2016). In addition, there are benefits to the assessment of long-term impact of the ‘triple dividend’ including comprehensive healthier trajectories, across the life course and healthiest possible start to life for the next generation. Finally, we encourage more studies with comparable design, control groups, and outcome measures to draw generalizable conclusions across studies. For instance, as noted in present systematic review, classroom-based interventions conducted in Indonesia, Sri Lanka, and Burundi were comparable; with homogenous intervention content and sociocultural context (Tol et al., 2008; Tol et al., 2012; Tol et al., 2014). Future efforts should consider initiatives such as systematic reviews and meta-analyses exploring effectiveness of homogenous interventions tested in study samples where recruitment, screening and outcome measures are comparable, as indicated in a recent review related to the role of universal school-based interventions on adolescent self-regulation (Pandey et al., 2018).

**CONCLUSION**

To our knowledge, this is the first systematic review and meta-analysis examining the underlying implementation processes of adolescent health programs, including which ‘life skills’ are utilized to effectively address the growing concern of adolescent mental health issues. In this study, we aimed to identify key implementation processes (related to who, what, where and how) and the effectiveness of life skills programs among adolescents in the LMIC which targeted at least one mental health outcome. Our findings demonstrated small to medium effect sizes for mental health outcomes and large effect sizes for relevant life skills across various adolescent health areas. This suggests an optimistic opportunity to address the growing burden of adolescent mental health and their co-occurring risk factors in LMICs. Furthermore, we found that trial effectiveness of life skills programs reflects three key relationships: the adolescent’s relationship with him/herself (i.e., stress management skills), his or her relations with others, notably peers (interpersonal skills) and with parents (child-parent interactions). Our findings thus highlight the critical importance of including parents to enhance the trial effectiveness measuring adolescent health outcomes. Finally, our results suggest that embedding the life skills program within an existing delivery platform with available delivery agents—such as training teachers in schools—may be one method to ensure that school-going adolescents are exposed to critical life skills which also serve to bolster their mental health.

The recent UN Global Strategy for Women’s, Children’s and Adolescents’ Health presents an unprecedented opportunity to invest in adolescent health (Kuruvilla et al., 2016). Governments and multilateral agencies are eager for scientific evidence that can guide programs and policies to achieve these ambitious targets. Policy makers face the challenge of understanding the nature of adolescents’ specific needs, their implication for policy and program development, and how to respond to adolescents’ priorities in the face of competing demands. Our results demonstrate the benefits of life skills programs targeting one or more mental health outcomes and co-occurring risk factors in school and community settings. Comprehensive programs focusing on multiple life skills related to the individual, his or her social environment as well as interventions focused on parent-child interactions may hold particular promise in LMIC to address the burden of poor mental health and other related health areas.

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**Contributors**

DRS drafted the report, in collaboration with AR and AW. DRS, SUH, and AR were responsible for the design of the study, with consultation from all authors. NS, SWZ and ZH were responsible for data extraction and analyses and were supervised by SUH and AW. DRS and AW was responsible for data syntheses and analyses. All authors contributed to the interpretation of the data. All authors reviewed and approved the manuscript.

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**Table 1. Search Strategy of Peer-Reviewed Articles.**

|  |  |
| --- | --- |
| **Focus** | **Search Terms** |
| 1. **Population** | (Adolescent OR adolescents OR Young OR youngsters OR youngster OR Youth OR teen OR teens OR teenagers OR teenage) |
| 1. **Intervention** | AND (comprehensive OR integrated OR multifaceted OR “multi component” OR multidimensional OR “multi dimensional” OR holistic OR Community OR “youth development” OR “youth program” OR “youth program” OR “teen program” OR “teen program” OR “adolescent program” OR “adolescent program” OR “school health” OR “family planning” OR health OR health-care**)** |
| 1. **Mental Health Outcome** | AND (“Mental health” OR psychosocial OR “Well-being” OR “life skills” OR “coping skills” OR “problem solving” OR empowerment OR social-support OR “self efficacy” OR resiliency OR resilience OR “self esteem” OR social OR suicide OR suicidality OR distress OR depression OR stress OR anxiety OR emotional) |
| 1. **Study Type: Clinical Trial** | AND (“Clinical trial” OR intervention OR trial OR “randomized controlled trial” OR RCT OR “cluster randomised control trial”)) |
| 1. **Region** | AND (“Middle income country” OR “Middle income countries” OR “low income countries” OR “low income country” OR LMIC OR “developing world” OR “developing country” OR “developing countries” OR Afghanistan OR “Kyrgyz Republic” OR Bangladesh OR Liberia OR Benin OR Madagascar OR “Burkina Faso” OR Malawi OR Burundi OR Mali OR Cambodia OR Mauritania OR “Central African Republic” OR Mozambique OR Chad OR Myanmar OR Comoros OR Nepal OR Congo OR Niger OR Eritrea OR Rwanda OR Ethiopia OR “Sierra Leone” OR Gambia OR The Somalia OR Guinea OR Tajikistan OR Guinea-Bissau OR Tanzania OR Haiti OR Togo OR Kenya OR Uganda OR Korea OR Zimbabwe OR Algeria OR Libya OR American Samoa OR Lithuania OR Angola OR Macedonia OR Antigua Barbuda OR Malaysia OR Argentina OR Maldives OR Azerbaijan OR Mauritius OR Belarus OR Mexico OR “Bosnia and Herzegovina” OR Montenegro OR Botswana OR Namibia OR Brazil OR Palau OR Bulgaria OR Panama OR Chile OR Peru OR China OR Romania OR Colombia OR Russian Federation OR Costa Rica OR Serbia OR Cuba OR Seychelles OR Dominica OR “South Africa” OR “Dominican Republic” OR “St Lucia” OR Ecuador OR “St Vincent” OR “The Grenadines” OR Gabon OR Suriname OR Grenada OR Thailand OR “Iran Islamic Republic” OR Iran OR Tunisia OR Jamaica OR Turkey OR Jordan OR Turkmenistan OR Kazakhstan OR Tuvalu OR Latvia OR Uruguay OR Lebanon OR Venezuela OR Albania OR Moldova OR Armenia OR Mongolia OR Belize OR Morocco OR Bhutan OR Nicaragua OR Bolivia OR Nigeria OR Cameroon OR Pakistan OR “Cape Verde” OR “Papua New Guinea” OR “Congo Republic” OR Paraguay OR “Cote d Ivoire” OR Philippines OR Djibouti OR Samoa OR “Egypt Arab Republic” OR Egypt OR “Sao Tome and Principe” OR “El Salvador” OR Senegal OR Fiji OR “Solomon Islands” OR Georgia OR “South Sudan” OR Ghana OR “Sri Lanka” OR Guatemala OR Sudan OR Guyana OR Swaziland OR Honduras OR “Syrian Arab Republic” OR India OR “Timor Leste” OR Indonesia OR Tonga OR Iraq OR Ukraine OR Kiribati OR Uzbekistan OR Kosovo OR Vanuatu OR “Lao PDR” OR Vietnam OR Lesotho OR “West Bank and Gaza” OR “Marshall Islands” OR “Yemen Republic” OR “Micronesia Federal States” OR Zambia) |

**Figure 1. Flow Chart.**

Records identified through database searching:  
  
Pubmed= 4,993Web of Science= 2,216Cochrane= 664Scopus= 425WHO Global Health Library= 0Virtual Health Library= 0

Studies included in qualitative synthesis   
(n = 50 trials from 45 articles included)

Records excluded   
(n = 6,847)

Records screened   
(n = 6,924)

Records after duplicates removed   
(n =1,401)

Additional records identified from  
bibliographies of included articles and 14 related review articles

## Identification

## Included

Full-text articles excluded (n=32)

Chronic conditions (n= 4)

Parenting program (n=1)

Incomplete data (n=1)

No mental health outcome (n=1)

No LMIC (n= 19)

Conference papers or no full texts (n=4)

Foster-care intervention (n=1)

No life skills (n=1)

Full-text articles assessed for eligibility   
(n = 77)

Studies included in   
meta-analysis  
  
(n = 50 trials from 45 articles included)

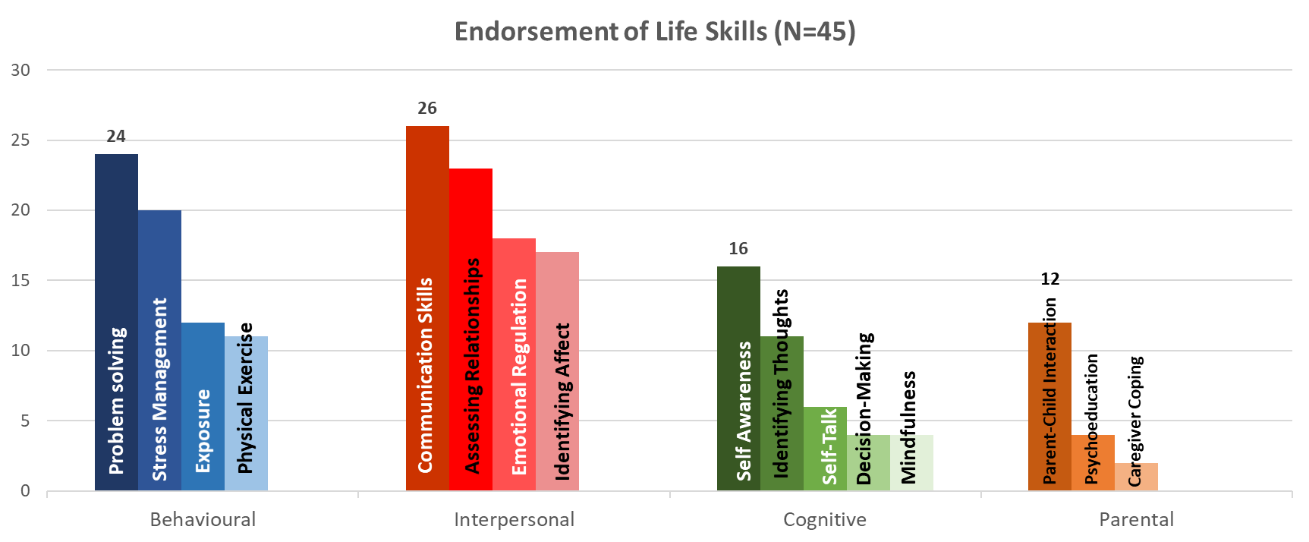
## Eligibility

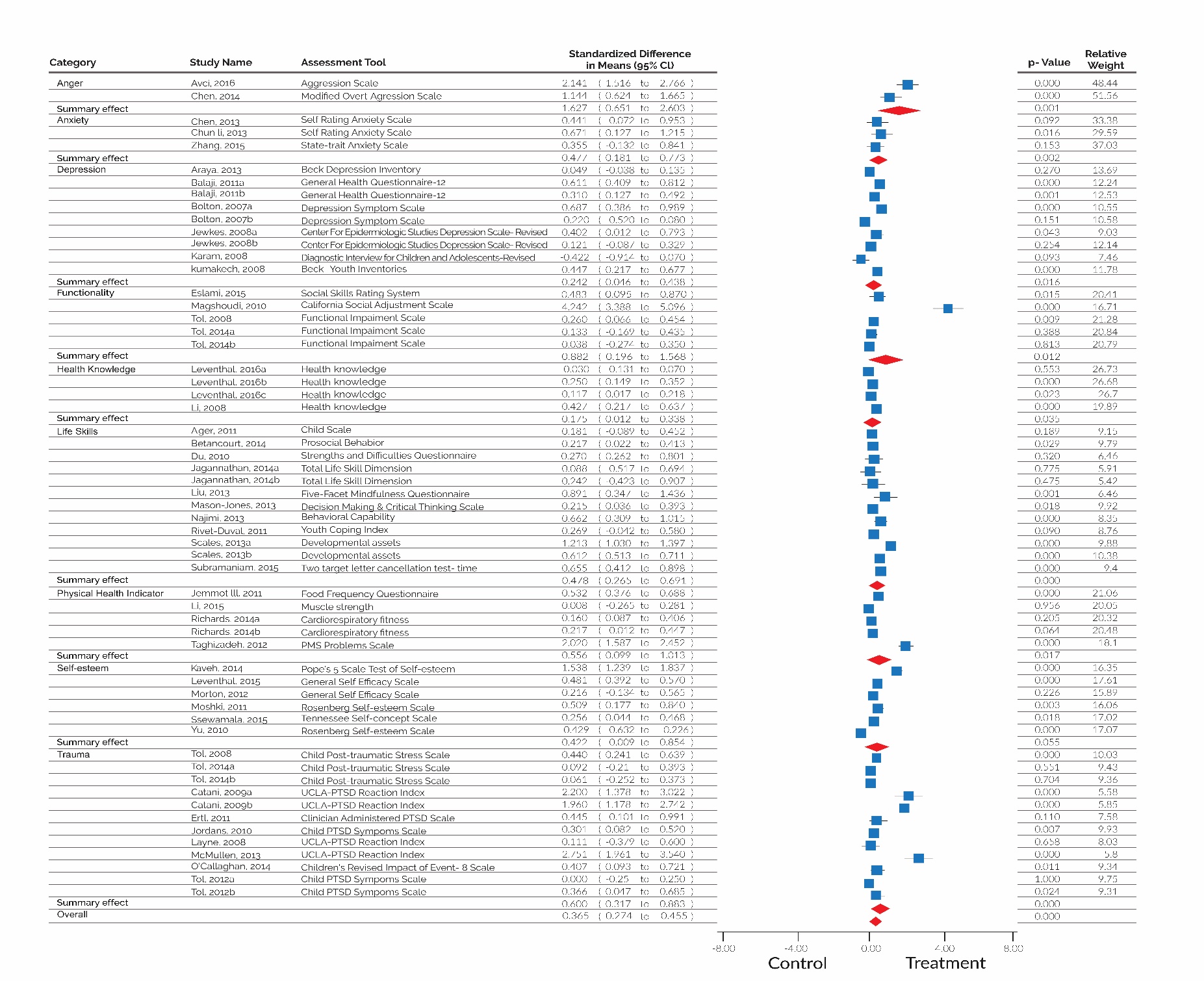
## Screening

**Table 2. Eligible studies and characteristics (N=45).**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Study  (Author, Year)** | **Country** | **Sample Size** | **Trial Design** | **Beneficiary Population** | **Recruitment Setting** | **Health Areas Targeted** |
| Ager, 2011 | Uganda | 403 | RCT | Children,  aged 7-12 | School | Mental Health (child-psychological well-being and resilience) |
| Araya, 2013 | Chile | 2512 | RCT | Adolescents, aged 13-15 | School | Mental Health (Depression, Anxiety, Problem Solving) |
| Avci, 2016 | Turkey | 385 | RCT | Adolescents, aged 14-16 | School | Mental Health (depression & anger) |
| Balaji, 2011 | India | 49,179 | RCT | Students, aged 16-24 | School | Mental Health, Sexual, Reproductive Health, substance use, behavior related to emotional health, physical abuse |
| Betancourt, 2014 | Sierra Leone | 436 | RCT | Torture victims, aged 15-24 | School | Mental Health (Psychological distress, pro-social attitudes/behaviors, emotion regulation, functional impairment, social support & Posttraumatic stress) |
| Bhana, 2014 | South Africa | 65 | RCT | Preadolescents, aged 10-13 | Other | Mental Health (Emotional symptoms, conduct, peer relations, Hyperactivity/inattentiveness, pro-social behavior), youth behavior, HIV treatment knowledge, stigma, adherence to medication, ART adherence, caregiver child communication, self-concept and future orientation |
| Bolton, 2007 | Uganda | 314 | RCT | Adolescents, aged 14-17 | Refugee camp | Mental Health (depression, anxiety, conduct problem symptoms, and functioning) |
| Catani, 2009 | Sri Lanka | 31 | RCT | Children, aged 8-14 | Refugee camp | Mental Health (depression & PTSD) |
| Chen, 2013 | China | 105 | RCT | Nursing Students, aged 18-22 | Other | Mental Health (anxiety and depression), & Physical health (heart rate and diastolic blood pressure) |
| Chen, 2014 | China | 66 | RCT | Young males, aged 14-24 | School | Mental Health (aggression, impulsivity & hostility) |
| Chun Li, 2014 | China | 60 | RCT | Students, age not specified | School | Mental Health (depression, anxiety, Perceived interpersonal social support, Coping style, & Self-esteem) |
| Du, 2010 | China | 56 | RCT | Adolescents, aged 12-17 | School | Mental Health (cognitive, behavioral and emotional health) |
| Eslami, 2015 | Iran, Islamic Rep. | 106 | RCT | Adolescents, age not specified | School | Mental Health (Self-rated social skills & Psychological well-being) |
| Ertl, 2011 | Uganda | 85 | RCT | Former child soldiers, aged 12-25 | Refugee camp | Mental Health (depression & PTSD) |
| Jegannathan, 2014 | Cambodia | 299 | RCT | Youth, age not specified | School | Mental Health (Psychological well-being, Interpersonal  communication/Human Relationship skills, Problem solving/Decision- making skills, Physical fitness/Health maintenance skills, and Identity development/Purpose in life skills) |
| Jemmott, 2011 | South Africa | 1057 | RCT | adolescents, aged 9-18 | School | Physical Health & other health areas (e.g. physical activity, Functioning/daily activity, & substance use) |
| Jewkes, 2008 | South Africa | 2776 | cRCT | Men & women, aged 15-26 | School | Mental Health (depression), Sexual & Reproductive Health (incidence of HIV, incidence of HSV-2, unwanted pregnancy, reported sexual practices, and substance misuse.) |
| Jordans, 2010 | Nepal | 325 | cRCT | Children, aged 11-14 | School | Mental Health (Psychological well-being, PTSD) |
| Karam, 2008 | Lebanon | 2500 | RCT | Children & Adolescents, aged 6-18 | Not specified | Mental Health (depression & psychosocial stressors) |
| Kaveh, 2014 | Iran | 223 | RCT | Female Students, age not specified | Not specified | Mental Health (Psychological well-being) |
| Kumakech, 2009 | Uganda | 326 | RCT | Children, aged 10-15 | Home | Mental Health (self-concept, anxiety, anger, and depression) |
| Layne, 2008 | Bosnia and Herzegovina | 127 | RCT | Adolescents, aged 13-19 | Home | Mental Health (depression & PTSD) |
| Leventhal, 2015 | India | 2308 | RCT | Adolescents, aged 11-12 | School | Mental Health & physical Health (depression, Emotional Resilience, Self-efficacy, Social Emotional Assets) |
| Leventhal, 2016 | India | 3000 | RCT | Adolescents, aged 11-12 | School | Mental Health & physical Health (behavior, wellbeing & attitudes) |
| Li, 2008 | China | 380 | RCT | Students, age not specified | School | Risk behaviors (intention of risk behaviors, and self–reported risk behaviors) |
| Li, 2015 | China | 222 | RCT | Students, aged 18-25 | School | Mental Health (stress, self-efficacy and attention) & physical health (lumbar muscle strength, lower limb proprioception function) |
| Liu, 2013 | China | 57 | RCT | Students, age not specified | Other | Mental Health (psychological well-being) |
| Magshoudi, 2010 | Iran | 69 | RCT | Students, aged 14-16 | School | Mental Health (social adjustment) |
| Mason 2013 | South Africa | 728 | RCT | Students, aged 15-16 | School | Mental Health, Sexual & Reproductive Health (sexual debut; for psychosocial outcome, decision-making) |
| McMullen 2013 | Congo. | 50 | RCT | Other, aged 13-17 | Other | Mental Health (depression & PTSD) |
| Morton 2012 | Jordan | 127 | RCT | Youth, aged 13-21 | Other | Mental Health (psychological well-being & self-efficacy) |
| Moshki 2012 | Iran, Islamic Rep. | 144 | RCT | Students, age not specified | School | Mental Health (Self-esteem, psychological well-being & locus of control) |
| Najimi 2013 | Iran, Islamic Rep. | 138 | RCT | Students, aged 6-11 | School | Mental Health (Behavioral capability, expectations, self-efficacy, observational learning) |
| O Callagan, 2014 | Congo, Dem. Rep. | 159 | RCT | Youth, aged 7-18 | School | Mental Health (psychological well-being & trauma) |
| Richards, 2014 | Uganda | 1462 | RCT | Adolescents, aged 11-14 | School | Mental health (depression) & Physical health (Cardiorespiratory fitness) |
| Rivet-Duval, 2011 | Mauritius | 160 | RCT | Adolescents, aged 12-16 | School | Mental Health (depression, hopelessness, coping skills & self-esteem) |
| Scales, 2013 | Bangladesh | 1000 | cRCT | Adolescents, aged 10-19 | Not specified | Overall health (developmental assets & social well-being of adolescents) |
| Ssewamala, 2016 | Uganda | 346 | cRCT | Children, aged 12-16 | School | Mental Health (psychological well-being, self-concept, hopelessness, & confidence) |
| Subramanian, 2015 | India | 439 | cRCT | Adolescents, aged 12-17 | School | Cognitive functioning |
| Taghizadeh, 2013 | Iran, Islamic Rep. | 123 | RCT | Adolescents, aged 15-19 | School | Mental Health, Sexual & Reproductive Health (premenstrual syndrome) |
| Tol, 2008 | Indonesia | 495 | cRCT | Children, aged 7-15 | School | Mental Health (depression & trauma) |
| Tol, 2012 | Sri Lanka | 399 | cRCT | Children, aged 9-12 | School | Mental Health (depression & trauma) |
| Tol, 2014 | Burundi | 329 | cRCT | Children, aged 8-17 | School | Mental Health (depression, anxiety, hope & trauma) |
| Yu, 2010 | China | 385 | RCT | Adolescents, aged 15-24 | Community | Sexual & Reproductive Health (sexual development, attitude, practice, contraception use, abortion choice, STDs, AIDS prevention, & self-esteem) |
| Zhang, 2015 | China | 66 | RCT | Adolescents, aged 14-24 | Other | Mental Health (depression, anxiety, social support, & coping styles) |

**Figure 2. WHAT Life Skills.**

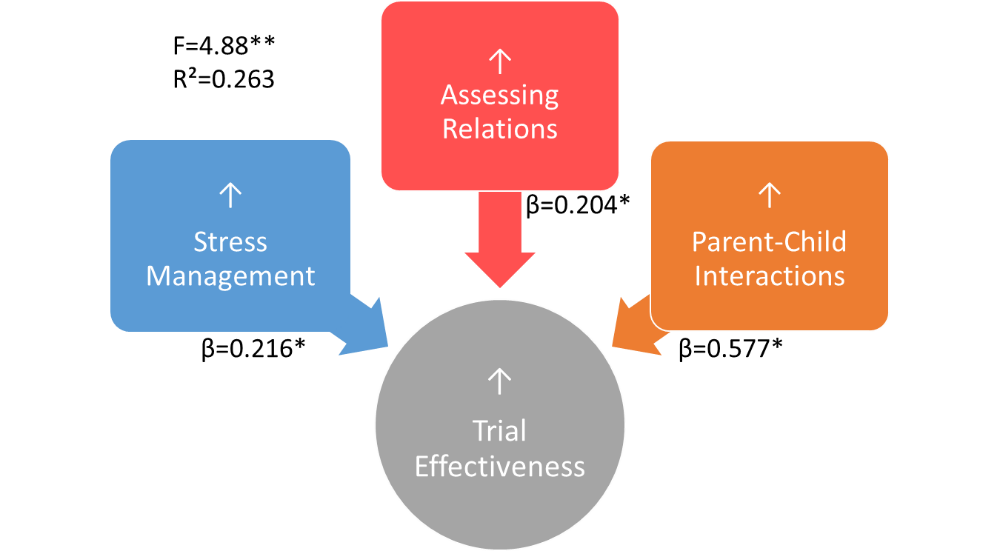
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**Figure 3. Life skills programs and their effect sizes on primary outcomes (N=45).**

**Figure 3 (continued).**

Note. Studies presented with multiple effect sizes in the forest plot, were presented as different datasets based on gender, nature of interventions or geographical affiliations. Balaji, 2011a refers to rural intervention arm based on vs. wait-list control (WLC), Balaji, 2011b urban intervention participants vs. WLC; Bolton, 2007a interpersonal therapy vs. WLC and Bolton, 2007b creative play vs. WLC; Jewkes, 2008a refers to male intervention participants and Jewkes, 2008b was based on female intervention participants vs. control; Tol, 2014a male intervention participants vs. WLC, Tol, 2014b female participants vs. WLC; Leventhal, 2016a, combined Resilience and Health curriculum vs. treatment-as-usual (TAU), Leventhal, 2016b, Health curriculum vs. TAU, Leventhal, 2016c, Resilience curriculum vs. TAU; Jagannathan, 2014a male participants vs. TAU and Jagannathan, 2014b females vs. TAU; Scales, 2013 basic peer education intervention improving social competency vs. control and Scales, 2013b intensive peer education program including social competency, financial competency and nutrition incentive vs. control; Richards, 2014a male vs. control Richards, 2014b female vs. control; Tol, 2012a males vs. WLC and Tol, 2012b females vs. WLC; Catani, 2009a meditation vs. control and Catani, 2009b narrative therapy vs. control.

**Figure 4. Life Skills and Trial Effectiveness (N=45).**

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Note. \**p*<0.05, \*\**p*<0.01