ORIGINAL ARTICLE

EFFECTIVENESS OF DIGITAL MEDIA TECHNOLOGY-BASED INTERVENTIONS ON HIV & STI RISK REDUCTION AMONG YOUNG PEOPLE: A META-ANALYSIS

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The authors declare that the data presented are original material and has not been previously published, accepted or considered for publication elsewhere; that the manuscript has been approved by all authors, and all authors have met the requirements for authorship.

3RD PRIZE 2019 PIDSP RESEARCH CONTEST

ABSTRACT

Background: Prevention strategies delivered through digital media technology (DMT) have been developed to reduce HIV incidence among young people. However, no best-practice DMT intervention strategies exist in handling HIV prevention programs among young people.

Objectives: To determine the effectiveness of DMT-based interventions in reducing risk-taking behaviours among young people that may predispose them to acquiring HIV and other sexually transmitted infections.

Subjects and Selection Criteria: Randomized controlled trials and quasi-experimental studies with rigorous controls comparing DMT-based interventions and controls on reducing risk-taking behaviors among young people aged 10-24 years were included.

Data Collection: Search methods were done on the following: MEDLINE, CENTRAL, Trials Register, Google Scholar, ScienceDirect, TRIP database, HERDIN, reference lists, & local databases until December 2017.

Analysis: Statistical analysis was done using Review Manager Version 5.3, heterogeneity examined, and analyses done under random effects model. Condom use, sexual behavior, number of sexual partners, STI testing, and sexual health knowledge in standardized effect sizes were calculated with 95% confidence intervals. Data were analyzed in subgroups: *Didactics*, *Modules*, *Virtual decision-making*.

Main Results: Identified sixteen studies with 7925 subjects comparing DMT interventions and controls. DMT interventions significantly increased condom use (d=0.29, 95% CI 0.18-0.41; p<0.00001), particularly in *Didactics* subgroup; and decreased frequency of sexual behavior (d=0.16, 95% CI 0.06-0.26; p=0.002), particularly in *Virtual decision-making* subgroup. Data significant but heterogeneous for improved sexual health knowledge. There was no statistical difference for decreased number of sexual partners and STI testing.

Conclusions: DMT-based interventions on condom use and frequency of sexual behavior were noted to be effective in reducing risk-taking behaviors among young people. These findings can be appropriately adapted for use in HIV/STI prevention campaigns.

KEYWORDS: *Digital media, HIV, STI, Adolescents*

INTRODUCTION

The Philippines is one of the seven countries that showed a dramatic increase in the number of new HIV cases. According to the HIV/AIDS & ART Registry of the Philippines (HARP), over 62,029 cases of HIV were reported since the year 1984 to December 2018. There is an average of 32 newly diagnosed cases of HIV per day, which are largely concentrated among key populations with risky behaviors, including unprotected sexual contact (mainly male-to-male). The youth age group (15-24 years old) comprises 29% of the reported cases and is the second highest new-case age range in the Philippines.[1]

Several activities have been implemented to campaign for HIV risk reduction including the development of National HIV Strategy Framework for Children and Young People, behavior change interventions, and school-based campaigns.[2] Various organizations in the Philippines, including Save the Children, Love Yourself PH, and the AIDS Society of the Philippines, have been tirelessly advocating for the prevention and treatment of HIV through raising awareness, highlighting the power and influence of social media, community involvement and advocacy through special events, and direct hands-on volunteer assistance.[3,4,5] To reduce the incidence of HIV among adolescents, interventions have been developed which range from broad factual discussions on HIV, instructional demonstrations on condom use, or motivational group sessions through various platforms including digital media. These digital media interventions would include programs delivered through webpages, texts, instant messaging programs, computer media technology, and mobile applications.[6,7,8,9] In a study by Daher *et al.* 2017, these digital media interventions work via various methods that includes simulations and role playing games that mimic certain key conditions and decision points prior to engaging in sexual encounters, social media interactions, avatar-guided computer programs, mobile apps, streamed soap opera videos, and combined innovations.[10] It may also include videos of vignettes of HIV+ individuals on how HIV affected their lives, interactive quizzes, online exercises and games, audio presentations, and modules on sexual and reproductive health.[11] These interventions work via presentation of key sexual risk reduction strategies through modules, didactic approaches, or real-life simulations. However, there are no best-practice intervention strategies yet that are unified in handling HIV awareness among adolescents and the youth.

Digital media technology-based interventions might work in HIV prevention programs for at-risk populations due to their low cost of delivery, customization of content and flexible dissemination with anonymity and privacy. Digital media has been found to be cost-effective and that they meet the complex needs of the underserved populations living with (or at a high risk of having) HIV/AIDS.[12] Among a variety of at-risk populations, computer-based interventions were found to hold promise in increasing the use of condoms and reducing sexual activity, number of sexual partners, and incident sexually transmitted infections, and were similar to commonly used human-delivered interventions in HIV prevention.[8] Digital media also work via creating a safe space for individuals to view materials, educate themselves, and address their concerns while maintaining anonymity and privacy.[13]

Heightened responsiveness in combination with behavioral control immaturity in adolescence contribute to making risky decisions.[14] The fact that there is a disproportionate HIV burden falling on this critical stage calls for the need of successful interventions critical to decrease risk of HIV and other sexually-transmitted infections (STI). Due to vastly expanding list of studies on various interventions in the reduction of HIV acquisition worldwide, especially in the dawn of new digital media technology-based interventions, it is useful to determine which intervention is effective and can

be adapted for use in HIV risk reduction campaigns for adolescents and youth. Recent randomized controlled trials have small samples and have low power to assess behavioral change, and this meta-analysis can possess more power to detect effects than individual studies.[15] This could also provide basis in establishing policies to utilize digital media in the implementation of HIV awareness, prevention, and risk reduction programs for adolescents and youth.

OBJECTIVES

The general objective of this meta-analysis is to determine the effectiveness of digital media technology (DMT)-based interventions in reducing risk-taking behaviors among young people that may predispose them to acquiring HIV and other STIs.

The specific objectives include determination of the effectiveness of DMT-based interventions in (1) improving intentions and actual condom use; (2) decreasing the frequency of sexual behavior or increase in delay in sexual activity (abstinence); (3) decreasing number of reported sexual partners (4) increasing STI testing measured through tests taken or indirectly through positive STI tests; and (5) improving sexual health knowledge, especially on HIV/AIDS awareness among young people.

METHODS

Criteria for considering studies for this meta-analysis

Types of studies - eligible studies are randomized controlled trials (RCTs) or quasi-experimental studies with rigorous controls.

Types of participants - young people (adolescents and youth), at least 10 to 24 years of age (comprising most of the population) or those who are at pre-tertiary level of education, regardless of sex and race with unknown HIV serostatus or HIV-negative individuals.

Types of interventions - interventions of interest involve digital media technology in the development or delivery of interventions that advocate HIV and STI risk reduction through educational, psychosocial, or behavioral approaches. Digital media technology-based interventions included prevention strategies delivered though computer-based or internet-based interventions, text/SMS-based strategies, desktop or laptop computers, mobile applications, interactive videos, telecommunication, videogames, or other digital media technology (DMT)-based approaches. Included studies tested the effectiveness of these DMT-based interventions on modifying sexual risk behaviors.

Types of outcome measures - studies with these outcomes should also provide the necessary information needed to calculate effect sizes.

Primary outcome - increase in measured actual condom use or intention to use condoms among study participants after exposure to intervention.

Secondary outcomes - (1) sexual behavior in terms of decrease in frequency or in terms of increased delay or abstinence; (2) decrease in number of partners involved in sexual activity; (3) increase in number of tests taken for detection of sexually transmitted infections other than HIV; and (4) improved sexual health knowledge.

Search methods for identification of studies

This meta-analysis employed search for relevant studies through several strategies. Studies that matched selection criteria and that were available as of December 2017 were included.

Electronic searches - search employed electronic reference databases, including: (1) PubMed/MEDLINE (2) ScienceDirect (3) Google Scholar (4) Turning Research into Practice (TRIP) database (5) Cochrane Review - CENTRAL (6) Trials Register and (7) Health Research and Development Information Network - HERDIN.

Requests were sent to researchers asking for copies of their papers applicable to this meta-analysis. Articles included in the reference sections

of existing list of articles were likewise searched. Local mobile applications and possible studies related to such apps were also searched.

Data Collection and Analysis

Selection of studies - search results were then merged using a reference management software (Mendeley Desktop v1.18) and it was ensured that no study was inadvertently included more than once in the meta-analysis. Titles and abstracts were examined to remove obviously irrelevant reports. Full texts of the potentially relevant reports were then retrieved and compiled. Each of the studies in the existing compilation were examined for compliance with the eligibility criteria by at least two authors to reduce the possibility of discarding relevant reports.[16] Disagreements were resolved through correspondence and discussion.

Data extraction and management - data from each of the selected studies were abstracted and coded into an electronic data spreadsheet (Microsoft Excel) and saved to file (and cloud for backup). Features included in the record included source details, eligibility and reasons for exclusion, sample demographics, type of DMT intervention used and details, methodological characteristics including research study design and type of comparison group, and outcomes assessed. Most of the data were derived from reports. The coders (authors) met to discuss each article after coding for any discrepancies. Intercoder reliability (Cohen's kappa statistic) was calculated to assess agreement between the authors. A value of κ = 0.69 was achieved, denoting substantial strength of intercoder agreement.[17]

Assessment of risk of bias in included studies - methodological quality to detect risks of bias was assessed independently by the review authors. Criteria outlined in the Cochrane Handbook for Systematic Reviews of Intervention[18] were followed. The following were assessed accordingly and stratified to low risk, high risk, or unclear: (1) sequence generation; (2) allocation concealment; (3) blinding; (4) incomplete outcome data; (5) selective reporting bias; and (6) other sources of bias. Disagreement was resolved through discussion of reviewers. If no agreement was reached, a third party was consulted.

Measures of treatment effect - effect sizes (standardized mean difference) indicated by using Cohen's *d*, were used to measure treatment effect. Cohen's *d* was used to standardize the results of studies to a uniform scale before combining,[18] hence delivering the same information regardless of the system used to obtain the observations.[19] These were calculated from data reported in each study using appropriate formulas and through the Review Manager v5.3 calculator. Effect sizes were reflected with 95% confidence intervals.

Unit of analysis issues - in cases in which more than one comparison condition exists within one study, the most minimal intervention was used to estimate "absolute" effect of the DMT-based intervention. All effect sizes were also computed using the longest-term follow-up assessment in studies with multiple follow-ups. Studies that showed DMT-based interventions outperforming controls will be given positive (+) effect sizes, otherwise they will be given negative (-) effect sizes.

Assessment of heterogeneity - in view of the clinical diversity within the set of chosen studies, a statistical test within the Review Manager v5.3 program was utilized to evaluate for heterogeneity (i.e., I^2 statistic, Chi^2 statistic). Heterogeneity was considered high when I^2 statistic exceeded 75% and Chi^2 *p* value was less than 0.1. Accurate extraction and recording of data were ensured to address clinical heterogeneity. Subgroup analysis was done to identify cause of heterogeneity.

Assessment of reporting biases - funnel plots were constructed from the intervention effect size estimates from the individual studies against its standard error. Failsafe tests were conducted and interpreted to assess reporting biases. In cases of outcomes in which there are less than ten studies available, funnel plot asymmetry tests were not

performed because their power is too low to distinguish chance from real asymmetry.[18]

Data synthesis - statistical analysis was done using Review Manager (RevMan) v5.3 software.[20] In light of the presence of clinical heterogeneity among studies in all outcomes, a random-effects model was used in this meta-analysis to avoid putting too much weight on large studies and to employ appropriate confidence intervals and p-values.

Subgroup analysis and investigation of heterogeneity - subgroup analyses were done considering the presence of clinical heterogeneity. Planned analyses in terms of sex, geographic location, and age subgroups were not feasible because specific data for each subgroup per study were not available for analysis. Subgroup analysis on main type of DMT-based intervention was used. These were categorized into:

1. *Didactics* - in which participants receive education and training through lectures delivered by videotaped actors or assisted by a counsellor through messaging systems
2. *Modules* - in which participants self-administer learning materials in pre-determined subsets of information in modular form
3. *Virtual decision-making* - in which participants encounter virtual simulations of real-life situations, decide on options and receive immediate feedback, education, and life skills.

Sensitivity analysis - sensitivity analysis was done to determine the effect of the quality of the trials without studies with high risk of bias (mostly the quasi-experimental studies).

RESULTS

Results of the Search

Extensive search through the several databases was accomplished using a pre-defined search strategy. Intervention search was intentionally designed to be broad in order to not miss relevant studies. The search yielded a total of 823 records. Additional 51 records were retrieved from searching other resources. Using a reference manager, duplicate records were eliminated to produce 860 records. Titles and abstracts were double-checked to remove obviously irrelevant reports. 674 records were excluded and if there is unclear eligibility based on the information provided, the study was retained for further evaluation.

Clinical trials were also searched revealing 87 records of ongoing and completed trials. Five studies were considered relevant in terms of intervention but only one of the five studies was retained for further evaluation. Local studies through HERDIN search yielded 178 records, in which seven studies were possibly relevant but did not meet inclusion criteria. Other local databases were searched for relevant studies but yielded no studies on effects of digital media-based technology on HIV risks.

One mobile application was found in searching local smartphone apps in the Philippines: "Battle in the Blood," a mobile game application designed to influence social norms, attitudes, and knowledge towards HIV/AIDS. An email was also sent to the mobile game developer to ask for potentially relevant studies involving this application. There were no published studies at the time of the search involving the use of this app in measuring HIV risk reductions among adolescents and youth.

A total of 186 records underwent further evaluation of abstracts and descriptions if they meet inclusion criteria. Full-text reports were retrieved for 35 articles and were examined for compliance with eligibility criteria, done by two independent reviewers. Sixteen studies were ultimately included in this meta-analysis, after eliminating studies for various reasons: k=8 studies were not randomized controlled trials, k=5 studies involved populations beyond youth age group, k=4 studies provided insufficient data needed to calculate effect sizes (e.g. no data table), and k=2 study had different outcomes measured.

Figure 1 shows the study flow diagram.

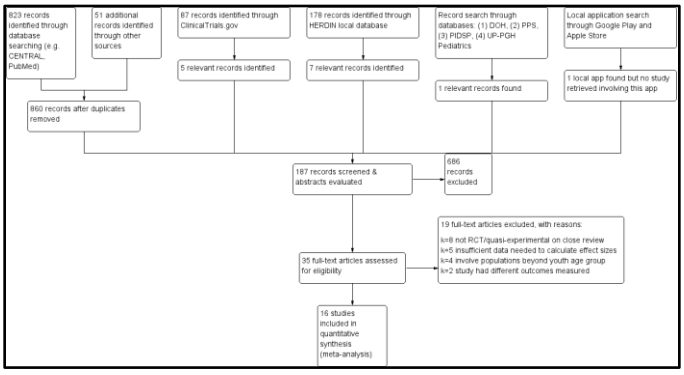

Figure 1. Study flow diagram

Included Studies

Population. The k=16 studies had a total N of 7925 and were published between 2004 to 2017. Two studies were split into two owing to them having two distinct populations each, making the total k=18. Most of the studies were conducted in the United States (k=14), and the others were conducted in Australia (k=1), China (k=1), and the Netherlands (k=1). One study did not specify its location of study. Twelve of the 18 studies involved both male and female participants while the rest (k=6) involved only females. Participants' age ranged from 11 to 25 years across all studies.

Study Design. Fourteen of the 18 studies were randomized controlled trials while the rest (k=4) where quasi-experimental studies with no mention of randomization but with rigorous controls. Follow-ups were scheduled in regular intervals up to six months (k=13; 3 studies having immediate follow-up), up to 24 months (k=4), and even as long as up to 36 months (k=1).

Program Characteristics. The most common intervention type were programs delivered via desktop computers on-site and/or internet-based (k=12). This was followed by virtual simulation and decision-making programs (k=2), text messaging and/or email messaging (k=2), videogame and/or interactive videos (k=2), telephone messaging (k=1), and television/radio-based programs (k=1). Most interventions utilize behavioral theories that have been commonly applied in HIV prevention. These studies were divided into subgroups as previously described; k=4 studies involved *Didactics*, k=7 studies utilized *Modules*, and k=7 studies employed *Virtual decision-making*.

Risk of Bias in Included Studies

Figure 2 presents the graphical summary of the risks of bias of the included studies.

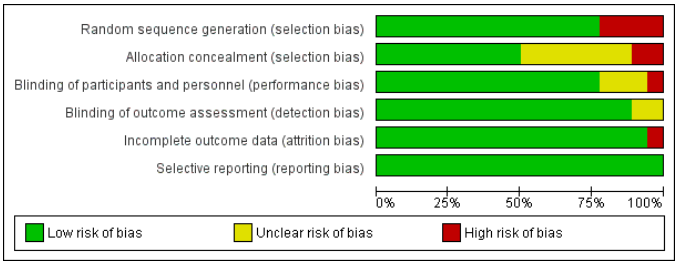

Figure 2. Risk of bias of included studies.

Selection Bias. Fourteen studies were randomized by software-generated random sequences. Four studies were marked high-risk [33,34,36]: these were the quasi-experimental studies, either randomization scheme was unclear, or investigators used institutional cycle design. In terms of allocation concealment, two studies were marked as high-risk since allocations were known to clinicians who sent emails to participants[30] or alternation was employed in allocation. Seven studies were marked unclear[25,26,33,34,36] since they did not specify how allocation was concealed. Most of the other studies were allocated using software algorithms independent of the investigators' knowledge.

Performance bias and detection bias. Only one study was marked as high risk for blinding of participants and personnel[28] since the study explicitly stated randomization of participants but in an unmasked fashion. Blinding was not specified in three studies[31,33,36] and were marked unclear. Most studies objectively collect data directly through participant answers, regardless of assigned group. In terms of blinding of outcome assessment, most studies employ self-reported outcomes. Two

studies were marked unclear[29,30] since it was not clear whether participants were blinded to the intervention they were taking.

Attrition Bias. Only one study was marked high risk[32] since their dropouts, although mentioned, were not included in study results. Other studies use intention-to-treat analyses, missing data balanced across groups, or reasons for missing data unrelated to outcome.

Reporting Bias. Expected outcomes were identified and reported as planned across all studies.

Efficacy of Interventions: Condom Use *(Figure 3)*

Thirteen studies were used to measure the primary outcome of condom use of young people. Analysis showed that the pooled standardized mean difference for this outcome was statistically significant at *d* = 0.29 (95% CI 0.18 to 0.41; Z = 4.97, *p*<0.00001; N = 5527). This meant that 61% of the intervention group was above the mean of the control group. There will be a 58% likelihood that any participant picked randomly from the DMT-based intervention group will be better at condom use than those from control.

To examine the possibility that publication bias inflated the condom use effect size (as evidenced by the funnel plot in Figure 4), fail-safe N values were calculated using the Rosenthal[21] and Orwin[22,23] methods. It would require 110 studies (by Rosenthal) or 287 studies (by Orwin) with non-significant findings to reduce the *d* = 0.31 to trivial effect.

Subgroup analysis was performed to address the presence of moderate heterogeneity (Tau² = 0.03; Chi² = 46.90, df = 13 (P < 0.0001); I² = 72%).

1. The *Didactics* subgroup (k=4) was homogeneous, and analysis showed statistically significant *d* = 0.55 (95% CI 0.41 to 0.68; Z = 7.89, p<0.00001, N = 866). This meant that 71% of the intervention group was above the mean of the control group. There will be a 65% chance that any participant picked randomly from the DMT-based *Didactics* subgroup will be better at condom use than those from control.
2. The *Modules* subgroup (k=5) was still moderately heterogeneous (I^2 = 61%), and analysis showed statistically significant *d* = 0.19 (95% CI 0.02 to 0.37; Z = 2.21, p=0.03; N = 1992). This meant that 58% of the intervention group was above the mean of the control group. There will be a 55% chance that any participant picked randomly from the DMT-based *Modules* subgroup will be better at condom use than those from control.
3. The *Virtual decision-making* subgroup (k=5) was still moderately heterogeneous (I^2 = 52%), and analysis showed statistically significant *d* = 0.25

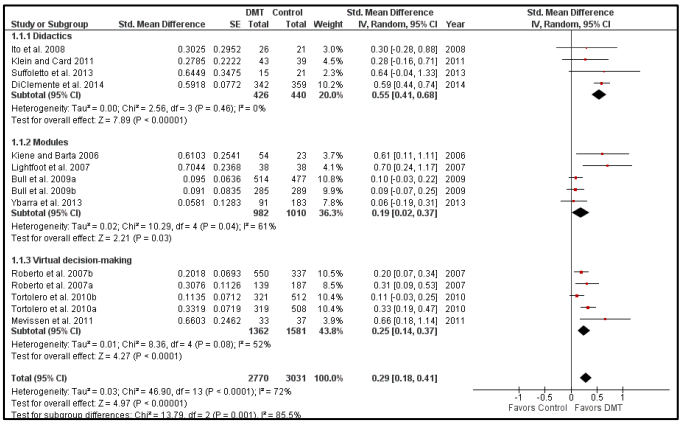

Figure 3. Forest plot comparing DMT-based interventions vs controls in increasing condom use among young people.

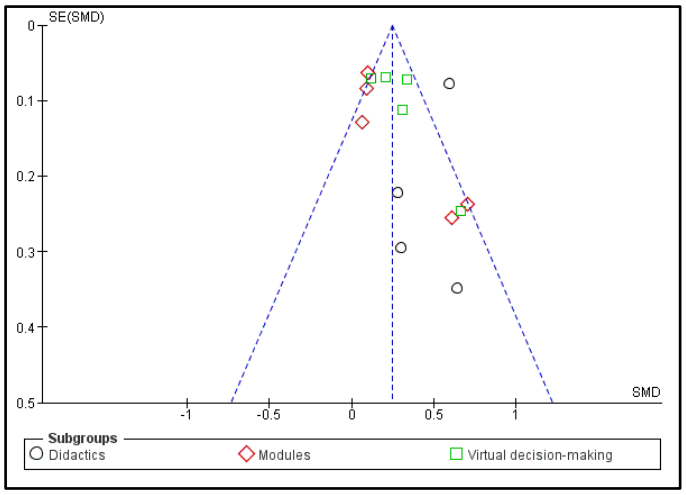

Figure 4. Funnel plot for condom use outcome.

(95% CI 0.14 to 0.37; Z = 4.27, p<0.0001; N = 2943). This meant that 60% of the intervention group was above the mean of the control group. There will be a 57% chance that any participant picked randomly from the DMT-based *Virtual decision-making* subgroup will be better at condom use than those from control.

In pursuing sensitivity analysis, it was noted that if quasi-experimental studies were excluded in the analysis of the *Modules* subgroup, the remaining k=4 studies would then have low heterogeneity (Tau^2 = 0; Chi^2 = 4.14, df = 3 (P = 0.25); I^2 = 28%). However, the pooled estimate for this outcome was not statistically significant at *d* = 0.11 (95% CI 0 to 0.23; Z = 1.91, p = 0.06; N = 1916).

Efficacy of Interventions: Frequency of Sexual Behavior *(Figure 5)*

Ten studies reported outcomes on frequency of sexual behavior, and the pooled standardized mean difference for this outcome was statistically significant at *d* = 0.16 (95% CI 0.06 to 0.26; Z = 3.12; p = 0.002; N = 4911). This meant that 56% of the intervention group was above the mean of the control group. There will be a 55% chance that any participant picked randomly from the DMT-based intervention group will have improved frequency of sexual behavior (abstinence) than those from control.

Figure 6 illustrates publication bias and Fail-safe N values were likewise computed for this outcome. It would require 27 studies (by Rosenthal) or 204 studies (by Orwin) with nonsignificant findings to reduce the *d* = 0.17 to trivial effect.

Subgroup analysis was performed to address the presence of moderate heterogeneity (Tau^2 = 0.02; Chi^2 = 25.83, df = 10 (P < 0.004); I^2 = 61%).

1. The *Didactics* subgroup (k=2) was homogeneous, but analysis showed results that are not statistically significant at *d* = 0.11 (95% CI -0.25 to 0.47; Z = 0.59, p = 0.55, N = 118).
2. The *Modules* subgroup (k=3) was highly heterogeneous (I^2 = 76%), and analysis showed

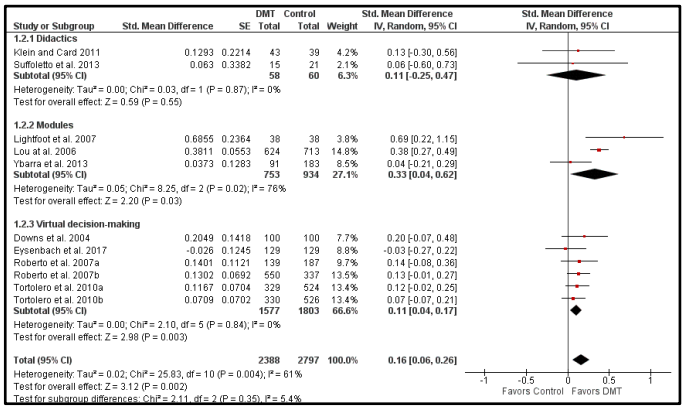

Figure 5. Forest plot comparing DMT-based interventions vs controls in decreasing sexual behavior among young people.

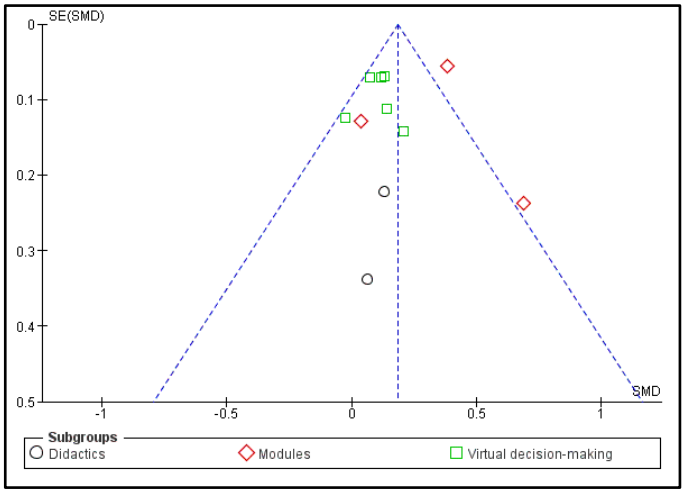

Figure 6. Funnel plot for frequency of sexual behavior as outcome.

statistically significant *d* = 0.33 (95% CI 0.04 to 0.62; Z = 2.20, p=0.03; N = 1687). This meant that 63% of the intervention group was above the mean of the control group. There will be a 59% chance that any participant picked randomly from the DMT-based *Modules* subgroup will have decreased frequency of sexual behavior than those from control.

3. The *Virtual decision-making* subgroup (k=6) was homogeneous, and analysis showed statistically significant *d* = 0.11 (95% CI 0.04 to 0.17; Z = 2.98, p = 0.003; N = 3380). This meant that 54% of the intervention group was above the mean of the control group. There will be a 53% chance that

any participant picked randomly from the DMT-based *Virtual decision-making* subgroup will have decreased frequency of sexual behavior than those from control.

In pursuing sensitivity analysis, it was noted that if quasi-experimental studies were excluded in the analysis of the whole group regardless of subgroup, the remaining k=7 studies would become homogeneous ($Tau^2 = 0$; $Chi^2 = 1.94$, df = 6 (P = 0.93); $I^2 = 0\%$). The pooled estimate for this outcome then was statistically significant at *d* = 0.09 (95% CI 0.01 to 0.16; Z = 2.04, p = 0.04; N = 2559).

Efficacy of Interventions: Number of Sexual Partners *(Figure 7)*

Two studies reported outcomes on number of sexual partners, and the pooled standardized mean difference for this outcome was not statistically significant at *d* = 0.42 (95% CI -0.13 to 0.98; Z = 1.50; p = 0.03; N = 402) and highly heterogeneous ($Tau^2 = 0.13$; $Chi^2 = 4.72$, df = 1 (P = 0.03); $I^2 = 79\%$). Subgroup analysis was not performed due to insufficient number of studies.

Efficacy of Interventions: STI Testing *(Figure 8)*

Three studies reported outcomes on STI testing, and the pooled standardized mean difference for this outcome was *d* = 0.26 (95% CI -0.06 to 0.58; Z = 1.59; p = 0.11; N = 629). However, data were highly heterogeneous ($Tau^2 = 0.06$; $Chi^2 = 6.75$, df = 2 (P = 0.03); $I^2 = 70\%$) and not statistically significant.

Efficacy of Interventions: Sexual Health Knowledge *(Figure 9)*

Six studies reported outcomes on sexual health knowledge, and the pooled standardized mean difference for this outcome was statistically significant at *d* = 0.42 (95% CI 0.26 to 0.57; Z = 5.31; p<0.0000 1; N = 4491). This meant that 66% of the intervention group was above the mean of the control group. There will be a 62% chance that any participant picked randomly from the DMT-based

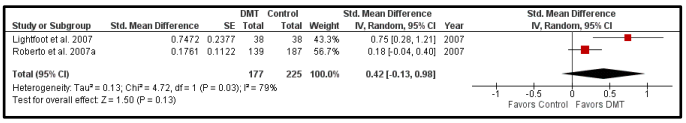

Figure 7. Forest plot comparing DMT-based interventions vs controls in decreasing number of sexual partners among young people.

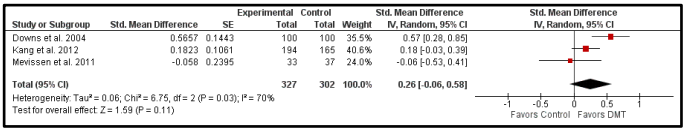

Figure 8. Forest plot comparing DMT-based interventions vs controls in improving STI testing among young people.

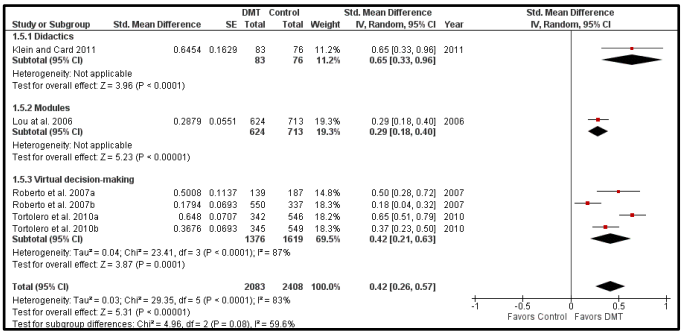

Figure 9. Forest plot comparing DMT-based interventions vs controls in improving sexual health knowledge.

intervention will have improved sexual health knowledge than those from control.

Subgroup analysis was performed to address the presence of high heterogeneity ($Tau^2 = 0.03$; $Chi^2 = 29.35$, df = 5 (P < 0.0001); $I^2 = 83\%$). However, the *Didactics* and *Modules* subgroups only had 1 study each and the rest (k=4) were under *Virtual decision-making* subgroup. Data remained heterogeneous ($Tau^2 = 0.04$; $Chi^2 = 23.41$, df = 3 (P <.0001); $I^2 = 83\%$) but statistically significant at *d* = 0.42 (95% CI 0.21 to 0.63; Z = 3.87; p = 0.0001; N = 2995).

DISCUSSION

Summary of Main Results

This meta-analysis highlights the effectiveness of digital media technology-based interventions in reducing risk-taking behaviors

among adolescents and youth that may predispose them to acquiring HIV and other STIs. In general, the pooled effect sizes of the selected studies show statistically significant adherence of participants to condom use. General heterogeneity was mainly attributed to the variety of digital media interventions used in each study. On closer look, the *Didactics* subgroup showed homogeneity and a statistically significant effect size in improving condom use. This could be due to role models (either videotaped narration or live interaction) serving as relevant avatars in guiding participants in the rationale, advantages, and correct use of condoms in sexual activity.

In terms of frequency of sexual activity, studies generally show significant effect sizes in decreasing frequency of sexual activity (or increasing waiting time or abstinence). Heterogeneity was mainly attributed as well to variety of interventions. On closer look, studies under *Virtual decision-making* subgroup show homogeneity and a statistically significant effect size. This could be due to the value of decision-making and immediate feedback on effects of such decisions (e.g. breaking abstinence) through simulated virtual dates, videogames, or cognitive rehearsals in selecting safe sex behaviors to practice.

Studies were also highly heterogeneous in terms of decreasing the number of sexual partners of young people owing to differences in interventions and possible differences in target population of the 2 studies (i.e. alternative education students). This outcome was also self-reported by participants, with one study having an unclear risk for performance bias. In any case, effect size was not statistically significant.

Digital media technology-based interventions did not show a statistically significant effect size on improving STI testing or detection. Studies were heterogeneous and type of intervention (computer-based recruitment or virtual STI clinic) seemed to have no significant effect on increasing STI testing. Studies also lack power (k=3) and there may be a need to conduct more randomized controlled trials in increasing testing among young people.

For sexual health knowledge, available data are heterogeneous owing to intrinsic differences in delivery of knowledge through didactic, modular, or virtual simulation approaches. Albeit the heterogeneity, the pooled effect size for the improvement of sexual health knowledge was considerable and statistically significant among studies and in all subgroups emphasizing the customization of rich content for immediate, low-cost delivery to target populations.

CONCLUSION & RECOMMENDATIONS

Implications for Practice

This meta-analysis was able to establish the effectiveness of digital media technology-based interventions in reducing risk-taking behaviors among young people as compared to controls. Programs in digital media form delivered via *Didactic* approaches are effective in increasing condom use while those with *Virtual decision-making* approaches are good for decreasing frequency of sexual behavior among adolescents and youth. Pending evaluations of cultural differences and digital media use in the country, these findings can be appropriately adapted for use in HIV/STI awareness, prevention, and risk reduction campaigns and policies considering the disproportionate HIV burden affecting the adolescent age group. Considering low cost of delivery, content customization, and flexible dissemination with anonymity and user privacy of digital media technology-based interventions, continued development and dissemination of such strategies can increase the public health impact of future HIV/STI programs.

This meta-analysis can open possibilities in the research of digital media technology-based interventions and their effects on not only changing individual-level behaviors but also addressing the

larger contextual landscape within which young people live. Studies focusing on effective types of digital media delivery on improving desired outcomes can be done. Local studies on effect of DMT-based interventions, such as mobile apps and games, on HIV/STI prevention are likewise recommended.

ACKNOWLEDGEMENTS

The authors would like to thank Dr. Al Joseph R. Molina and Mr. Alvin Rio U. Valdeztamon for their statistical assistance in this meta-analysis. Cohen's *d* interpretation was made possible through the help of Mr. Kristoffer Magnusson. Special thanks to Dr. Katrina Anne T. Cordova and Dr. Dior S. Dy for their editing assistance.

DECLARATIONS OF CONFLICTS OF INTEREST

The authors have no conflict of interest. No funding for this study was received.

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Included Studies

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