

Review article

Adolescent Health Interventions: Conclusions, Evidence Gaps, and Research Priorities



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JOURNAL OF ADOLESCENT HEALTH

www.jahonline.org

Rehana A. Salam, M.Sc.^a, Jai K. Das, M.D., M.B.A.^a, Zohra S. Lassi, Ph.D.^b, and Zulfiqar A. Bhutta, Ph.D.^{c,d,*}

^a Division of Women and Child Health, Aga Khan University, Karachi, Pakistan

^bRobinson Research Institute, University of Adelaide, Adelaide, Australia

^c Centre for Global Child Health, The Hospital for Sick Children, Toronto, Ontario, Canada

^d Center of Excellence in Women and Child Health, The Aga Khan University, Karachi, Pakistan

Article history: Received January 25, 2016; Accepted May 3, 2016 *Keywords:* Adolescent health; Adolescent sexual health; Substance abuse; Mental health; Adolescent nutrition; Adolescent immunization; Injury prevention

ABSTRACT

Adolescent health care is challenging compared to that of children and adults, due to their rapidly evolving physical, intellectual, and emotional development. This paper is the concluding paper for a series of reviews to evaluate the effectiveness of interventions for improving adolescent health and well-being. In this paper, we summarize the evidence evaluated in the previous papers and suggest areas where there is enough existing evidence to recommend implementation and areas where further research is needed to reach consensus. Potentially effective interventions for adolescent health and well-being include interventions for adolescent sexual and reproductive health, micronutrient supplementation, nutrition interventions for pregnant adolescents, interventions to improve vaccine uptake among adolescents, and interventions for substance abuse. Majority of the evidence for improving immunization coverage, substance abuse, mental health, and accidents and injury prevention comes from high-income countries. Future studies should specifically be targeted toward the low- and middle-income countries with long term follow-up and standardized and validated measurement instruments to maximize comparability of results. Assessment of effects by gender and socioeconomic status is also important as there may be differences in the effectiveness of certain interventions. It is also important to recognize ideal delivery platforms that can augment the coverage of proven adolescent health-specific interventions and provide an opportunity to reach hard-toreach and disadvantaged population groups.

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E-mail address: zulfigar.bhutta@sickkids.ca (Z.A. Bhutta).

Adolescent health care is challenging compared to that of children and adults, due to their rapidly evolving physical, intellectual, and emotional development [1,2]. Evidence from high-income countries as well as low- and middle-income countries (LMICs) suggests that services targeting adolescents are highly fragmented, poorly coordinated, and uneven in quality [3]. Furthermore, health practitioners face several challenges with adolescents as they require specialized skills for consultation, interpersonal communication, and interdisciplinary care. This paper is a concluding paper for a series of reviews conducted

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http://dx.doi.org/10.1016/j.jadohealth.2016.05.006

Conflicts of Interest: The authors do not have any financial or nonfinancial conflicts of interest for this review.

Disclaimer: Publication of this article was supported by the Bill and Melinda Gates Foundation. The opinions or views expressed in this supplement are those of the authors and do not necessarily represent the official position of the funder.

^{*} Address correspondence to: Zulfiqar A. Bhutta, Ph.D., Centre for Global Child Health, The Hospital for Sick Children, 686 Bay Street, Toronto, Ontario M6S 1S6, Canada.

to evaluate the effectiveness of interventions for improving adolescent health and well-being. Previous seven paper focused on the background, methodology, and conceptual framework [4]; interventions for adolescent sexual and reproductive health [5]; interventions to promote adolescent nutrition [6]; interventions to improve access and coverage of adolescent immunizations [7]; interventions to prevent substance abuse [8]; interventions for adolescent mental health and violence prevention [9]; and interventions to prevent accidents and unintentional injuries among adolescents [10]. Our aim was to look at the holistic evidence around the interventions identified in our conceptual framework for which we took a systematic approach to consolidate the existing evidence through three methodologies: overview of systematic reviews, updating existing reviews, and conducting de novo reviews where no reviews existed, the details of which are described in a separate paper [4]. In this paper, we summarize the evidence evaluated in the previous papers and suggest areas where there is enough existing evidence to recommend implementation and areas where further research is needed to reach consensus.

Evidence Summary

- Our review findings suggest that interventions for adolescent sexual and reproductive health including education, counseling, and contraceptive provision are effective in increasing sexual knowledge, contraceptive use, and decreasing adolescent pregnancy. Among interventions to prevent female genital mutilation/ cutting, community mobilization and female empowerment strategies have the potential to raise awareness of the adverse health consequences of female genital mutilation/cutting and reduce its prevalence; however, there is a need to conduct methodologically rigorous intervention evaluations. There was limited and inconclusive evidence for the effectiveness of interventions to prevent intimate partner violence [5].
- Review on adolescent nutrition interventions suggests that micronutrient supplementation among adolescents (predominantly females) can significantly decrease anemia prevalence, while interventions to improve nutritional status among 'pregnant adolescents' significantly improved birth weight and decreased low birth weight and preterm delivery. Interventions to promote nutrition and prevent obesity had a marginal impact on body mass index (BMI) [6].
- Evidence on interventions to improve immunization uptake suggested an overall increase in vaccination coverage through implementing vaccination requirement in school and sending reminders and national permissive recommendation for adolescent vaccination. Interventions to improve vaccine coverage also led to significant declines in the prevalence of human papillomavirus, genital warts, varicella deaths, measles incidence, rubella susceptibility, and incidence of pertussis; however, the data are from very limited and low-quality studies [7].
- Evidence on substance abuse suggest that among smoking/ tobacco interventions; school based prevention programs and family based intensive interventions typically addressing family functioning are effective in reducing smoking, mass media campaigns are also effective given that these were of reasonable intensity over extensive periods of time. Among interventions for alcohol use; school based alcohol prevention interventions have been associated with reduced frequency of drinking, family based interventions have a small but persistent effect on alcohol misuse among adolescents. For

drug abuse; school based interventions based on a combination of social competence and social influence approaches have shown protective effects against drugs and cannabis use. Among the interventions targeting combined substance abuse; school based primary prevention programs are effective. Evidence from internet based interventions, policy initiatives and incentives appears to be mixed and needs further research. [8].

- Evidence from school based mental health interventions suggest that targeted group-based interventions and cognitive behavioral therapy (CBT) were found to be effective in reducing depressive symptoms and anxiety. School based suicide prevention programs suggest that classroom-based didactic and experiential programs increased short-term knowledge of suicide and knowledge of suicide prevention with no evidence of an effect on suicide-related attitudes or behaviors. Community based creative activities had some positive effect on behavioral changes, self-confidence, selfesteem, levels of knowledge and physical activity. Evidence from digital platforms supports internet-based prevention and treatment programs for anxiety and depression. Among individual and family based interventions; interventions focusing on eating attitudes and behaviors showed no impact on BMI; eating attitude test (EAT); and bulimia. Exercise was found to be effective in improving self-esteem and reducing depression score with no impact on anxiety scores [9].
- Among interventions to prevent unintentional injuries, graduated driver license (GDL) significantly reduced road accidents. There was no impact of GDL programs on incidence on injuries, helmet use and seatbelt use. Sports-related injury prevention interventions led to reductions in the incidence of injuries, incidence of injury per hour of exposure and injuries per number of exposures. Subgroup analysis according to the type of interventions suggests that training ± education and the use of safety equipment had significant impacts on reducing the incidence of injuries [10].

The impact estimates for all interventions reviewed are summarized in Table 1.

Data Gaps

Most of the outcomes were rated as low or moderate in methodological quality due to lack of rigorous study designs as many of the studies used before-after designs without comparable controls. Trial designs also continued to be compromised by nonrandom allocations as randomization and allocation concealment was not always possible due to the nature of the intervention. Many of the studies focusing on behavior change interventions did not use standardized outcome measures and hence could not be pooled. Many studies also had short followup duration. Since majority of the behavior change and psychosocial interventions require a longer duration to achieve an impact, they might not have been able to capture the actual impact. There was lack of evidence on marginalized populations and also on differences of effects according to gender. Most of studies for improving immunization coverage, substance abuse, mental health, and accidents and injury prevention have been completed predominately in high-income countries, and although there is evidence on a more multicultural population in these countries, specific impacts on these disadvantaged populations could not be drawn.

Table 1

Summary of findings for the effect of adolescent health interventions

Sexual and reproductive health interventionsMean knowledge scoreSMD: 2.04 (1.31, 2.78)Sexual encounterRR: 1.11 (1.04, 1.20)Mean efficacy scoreSMD: 78 (22, 1.30)Sexual encounterRR: 1.10 (9.3, 1.07)Use of any contraceptionRR: 1.57 (1.04, 1.4)STIRepeat teenage pregnanciesRR: 53 (1.48, 5.2)Preventing fenale genital mutilationRR: 1.53 (1.47, 3.64)Knowledge of harmful consequencesRR: 1.53 (1.08, 2.16)Preventing fenale genital mutilationRR: 6.3 (4.9, .82)Freework (1.6, 1.0, 1.17)Skills related to relationship violenceSMD: -0.0 (11, .17)Beher that FCM/C compromise humanRR: 7.1 (5.3, 1.13)Skills related to relationship violenceSMD: 0.03 (11, .17)Behar that FCM/C compromise besityMonoine differenceSMD: -0.08 (17, .01)Knowledge related to relationship violenceSMD: 4.4 (2.8, .60)Promoting healthy nutrition and preventing obesityMonoine differenceRR: 7.3 (.57, .95)Iton-deficiency anemiaRR: 7.3 (.57, .95)Matricon Uritient supplementationSMD: -17 (58, .23)Iton-deficiency anemiaRR: 7.3 (.57, .95)Iton-deficiency anemiaRR: 2.6 (.23, .30)Mumps incidenceRR: 1.2 (0.3, .38)HPV incidenceRR: 2.6 (.23, .30)Mumps incidenceRR: 2.6 (.23, .30)Mumps incidenceRR: 2.6 (.24, .21)HPV -vaccine coverageRR: 1.5 (1.1, .24)RR: 1.5 (1.1, .24)Matritis sinclenceRR: 2.6 (.25, .84)HPVvaccine coverageRR: 1.5 (1.1, .24)RR: 1.5 (.1, .24)Murps incidenceRR: 9.6 (.52, .84)	Outcome	RR/SMD (95% CI)	Outcome	RR/SMD (95% CI)		
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Promoting healthy nutrition and preventing obesity SMD: -0.8 (17, 0.1) Mean BMI SMD: -0.8 (17, 0.1) Micronutrient supplementation R8: 69 (62, 7.6) Nutrition for pregnant adolescents R8: 25 (0.8, 41) Preterm delivery R8: .73 (.57, .95) Low birth weight R8: .70 (.57, .84) Iron-deficiency anemia R8: .34 (.13, .89) Serum calcium SMD: -17 (58, .23) Adolescent immunization R8: .66 (.42, .21) HPV incidence R8: .26 (.23, .30) Measles incidence R8: .15 (6 (.42, .21) HPV prevalence R8: .56 (.38, .82) Varicella deaths R8: .176 (.17, .13, .180) Meningococcal vaccine uptake R8: .15 (6 (.44, .167) HPVCIN3 incidence R8: .17 (.15, .46) Multivaccine coverage R8: .17 (.12, .01, .12) Rubella susceptibility R8: .27 (.15, .46) Multivaccine coverage R8: .178 (.141, .223) HPV-weiting substance abuse Smoking uptake (pure prevention) R8: .86 [.29, .94] Frequency of drinking days SMD: .07 [.02, .13] Smoking at follow-up R8: .86 [.42, .96] Frequency of drinking days SMD: .07 [.02, .13] Greenter Smoking R8: .73 [.64, .82] Hard drug use (>12 months) R8: .86 [.39, .190] <t< td=""><td>Behavior related to relationship violence</td><td>SMD:07 (31, .16)</td><td>Knowledge related to relationship violence</td><td>SMD: .44 (.28, .60)</td></t<>	Behavior related to relationship violence	SMD:07 (31, .16)	Knowledge related to relationship violence	SMD: .44 (.28, .60)		
Mean BMSMD: $08 (17, 0.1)$ Micronutrient supplementation AnemiaRR: $.69 (.62, .76)$ Nutrition for pregnant adolescentsRR: $.69 (.62, .76)$ Mean birth weightRR: $.25 (.08, .41)$ Preterm deliveryRR: $.73 (.57, .95)$ Low birth weightRR: $.70 (.57, .84)$ Iron-deficiency anemiaRR: $.34 (.13, .89)$ Serum calciumSMD: $17 (58, .23)$ Adolescent immunizationRR: $.26 (.23, .30)$ Mean birth weightRR: $.96 (.42, .21)$ HPV incidenceRR: $.26 (.23, .30)$ Mumps incidenceRR: $.96 (.42, .21)$ HPV prevalenceRR: $.56 (.38, .82)$ Varicella deathsRR: $.74 (.56, .98)$ HPVvaccine coverageRR: $.15 (.01, .246)$ Pertussis incidenceRR: $.24 (.16, .36)$ HPVvaccine uptakeRR: $.15 (.12, .246)$ Pertussis incidence of genital wartsRR: $.27 (.15, .46)$ Multivaccine coverageRR: $.178 (.141, .2.3)$ HPV-endicence of genital wartsRR: $.66 (.52, .84)$ HPV-waccine uptakeRR: $.178 (.141, .2.3)$ Preventing substance abuseFrequency of drinking daysSMD: 07 [.01, .14]Smoking uptake (pure prevention)RR: $.88 [.82, .96]$ Frequency of heavy drinking daysSMD: 07 [.01, .14]Smoking at follow-upRR: $.88 [.82, .96]$ Frequency of heavy drinking daysSMD: 07 [.01, .14]Smoking at follow-upRR: $.88 [.79, .94]$ Marijuana use (>12 months)RR: $.83 [.69, .99]$ (imode-free class competition)SME: $.79 [.76, .48]$ Land drug use (>12 months)RR: $.86 [.39, .190]$ 30-day smoking<	Promoting healthy nutrition and preventing obesi	ty	Ŭ I			
Micronutrient supplementationRR: 69 (62, .76)AnemiaRR: 69 (62, .76)Mutrition for pregnant adolescentsRR: 25 (08, .41)Mean birth weightRR: .25 (08, .41)Iow birth weightRR: .70 (.57, .84)Iron-deficiency anemiaRR: .34 (.13, .89)Serum calciumSMD:17 (58, .23)Adolescent immunizationMurps incidenceMumps incidenceRR: .12 (.03, .38)Mumps incidenceRR: .26 (.22, .21)Mumps incidenceRR: .26 (.42, .21)Meales incidenceRR: .156 (.145, .167)Meningococcal vaccine uptakeRR: .156 (.145, .167)Methale soccal vaccine uptakeRR: .27 (.15, .46)Mutocaccal vaccine uptakeRR: .27 (.15, .46)Mutocace of egnital wartsRR: .27 (.15, .46)Mutocace of egnital wartsRR: .59 (.42, .23)Freeventing substance abuseFrequency of drinking daysSmoking uptake (pure prevention)RR: .88 [.82, .96]Regular smokingRR: .79 (.59, .44, .82]Hard drug use (>12 months)RR: .86 [.39, .99](smoke-free class competition)RR: .73 [.64, .82]Hard drug use (>12 months)RR: .86 [.39, .190]30-day smokingRR: .73 [.64, .82]Alcohol consumptionSMD: .72 [.36, 1.07]Interventions for mental healthKr58 [.46, .07]Knowledge of suicide preventionSMD: .72 [.36, 1.07]Interventions for mental healthKr58 [.46, .97, .34]Interventions for mental healthKr30 [.73, .66]Interventions for mental health <td>Mean BMI</td> <td>SMD:08 (17, .01)</td> <td></td> <td></td>	Mean BMI	SMD:08 (17, .01)				
AnemiaRR: .69 (.62, .76)Nutrition for pregnant adolescents	Micronutrient supplementation					
Nutrition for pregnant adolescents Nutrition for pregnant adolescents RR: 25 (08, 41) Preterm delivery RR: 73 (57, 95) Mean birth weight RR: 26 (057, 84) Iron-deficiency anemia RR: 34 (13, 89) Serum calcium SMD: -,17 (-,58, 23) HPV RR: 36 (23, 30) Adolescent immunization Measles incidence RR: 12 (03, 38) HPV incidence RR: 26 (23, 30) Mumps incidence RR: 12 (03, 38) HPV-vacine coverage RR: 56 (38, 82) Varicella deaths RR: 74 (56, 98) HPV-vacine coverage RR: 15 (01, 246) Meningococcal vaccine uptake RR: 156 (145, 1.67) HPV-vaccine uptake RR: 12 (120, 1.23) Rubella susceptibility RR: 27 (15, 46) Multivaccine coverage RR: 1.78 (1.41, 2.23) HPVincidence of genital warts RR: 66 (52, 84) Preventing substance abuse RR: 88 [82, 96] Smoking uptake (pure prevention) RR: 88 [82, 96] Frequency of drinking days SMD: 07 [-01, .14] Smoking uptake (pure prevention) RR: 88 [82, 96] Frequency of heavy drinking SMD: 07 [-01, .14] Smoking uptake (pure prevention) RR: 86 [79, 94] Marijuana use (>12 mont	Anemia	RR: .69 (.62, .76)				
Mean birth weightRR: 25 (0.8, 41)Preterm deliveryRR: 73 (57, 95)Low birth weightRR: 70 (57, 84)Iron-deficiency anemiaRR: 34 (13, 89)Serum calciumSMD: 17 (-58 , 23)Hordeficiency anemiaRR: 34 (13, 89)Adolescent immunizationMaine SincidenceRR: 12 (03, 38)HPV incidenceRR: 56 (23, 30)Mumps incidenceRR: 12 (03, 38)HPV-incidenceRR: 56 (38, 82)Varicella deathsRR: 74 (56, 98)HPVvaccine coverageRR: 176 (1.73, 1.80)Meningococcal vaccine uptakeRR: 126 (145, 1.67)HPVcuccine coverageRR: 1.12 (12, 1.23)Rubella susceptibilityRR: 27 (15, 46)Multivaccine coverageRR: 1.78 (1.41, 2.23)Rubella susceptibilityRR: 27 (15, 46)Multivaccine coverageRR: 1.78 (1.41, 2.23)HPVincidence of genital wartsRR: 66 (52, 84)Preventing usbastne abuseRR: 59 [42, 83]Smoking uptake (pure prevention)RR: 88 [82, 96]Frequency of drinking daysSMD: 07 [.02, .13]gendar smokingRR: 59 [42, 83]Frequency of heavy drinkingSMD: 07 [.02, .13]gendar smoking at follow-upRR: 88 [.87, 96]Arid drug use (>12 months)RR: 86 [.39, .190]30-day smokingRR: 73 [.64, 82]Hard drug use (>12 months)RR: 86 [.39, .190]30-day smokingRR: 73 [.64, .82]Cannabis useSMD: $16 [26,05]$ Alcohol consumptionSMD: $31 [.07, .19]$ Evertions for metal healthSMD: $31 [.57, .245]$ Knowledge of suicide preventionSMD: $31 [.59,06]$ <td< td=""><td>Nutrition for pregnant adolescents</td><td></td><td></td><td></td></td<>	Nutrition for pregnant adolescents					
	Mean birth weight	RR: .25 (.08, .41)	Preterm delivery	RR: .73 (.57, .95)		
Serum calciumSMD: 17 (58 , 23)Adolescent immunizationMeasles incidenceRR: $.12$ (03 , $.38$)HPV incidenceRR: $.26$ ($.23$, $.30$)Mumps incidenceRR: $.96$ ($.42$, 2.21)HPV prevalenceRR: $.56$ ($.38$, $.82$)Varicella deathsRR: $.74$ ($.56$, $.98$)HPV—cIN3 incidenceRR: $.15$ ($.17$, 1.80)Meningococcal vaccine uptakeRR: $.16$ (1.45 , 1.67)HPV—cIN3 incidenceRR: $.15$ ($.17$, 2.46)Pertussis incidenceRR: $.24$ ($.16$, $.36$)HPV—cIN3 incidenceRR: $.121$ (1.20 , 1.23)Rubella susceptibilityRR: $.27$ ($.15$, $.46$)Multivaccine coverageRR: $.178$ (1.41 , $.223$)HPV—incidence of genital wartsRR: $.66$ ($.52$, $.84$)HPV—incidence of genital wartsRR: $.66$ ($.52$, $.84$)Preventing substance abuseRR: $.66$ ($.52$, $.84$)HPV—incidence of genital wartsRR: $.66$ ($.52$, $.84$)Smoking uptake (pure prevention)RR: $.88$ [$.82$, $.96$]Frequency of drinking daysSMD: $.07$ [$.02$, $.13$]Regular smokingRR: $.73$ [$.64$, $.82$]Hard drug use (>12 months)RR: $.83$ [$.69$, $.99$](smoke-free class competition)SMD: $.13$ [$.07$, $.19$](quantity/week/month)RR: $.56$ ($.52$, $.61$]Interventions for mental healthKr. $.79$ [$.70$, $.61$, $.72$ [$.36$, $.107$]DepressionSMD: 16 [26 , 05]AnxietySMD: 33 [59 , 06]Knowledge of suicideSMD: $.15$ [$.57$, 2.45]Accident and injury preventionRR: $.66$ ($.59$, $.73$)Helmet useRR: $.100$ ($.98$, $.102$)<	Low birth weight	RR: .70 (.57, .84)	Iron-deficiency anemia	RR: .34 (.13, .89)		
Adolescent immunizationHPV incidenceRR: .26 (.23, .30)Measles incidenceRR: .96 (.42, 2.21)HPV prevalenceRR: .56 (.38, .82)Mumps incidenceRR: .74 (.56, .98)HPV—vaccine coverageRR: .1.5 (.1, .31, .80)Meningococcal vaccine uptakeRR: .1.56 (.1.45, .1.67)HPV—Uraccine coverageRR: .1.5 (.1, .2.46)Pertussis incidenceRR: .24 (.16, .36)HPV—vaccine uptakeRR: .1.21 (.1.20, 1.23)Rubella susceptibilityRR: .27 (.1.5, .46)Multivaccine coverageRR: .1.78 (.1.41, .2.23)HPV—incidence of genital wartsRR: .66 (.52, .84)Preventing substance abuse </td <td>Serum calcium</td> <td>SMD:17 (58, .23)</td> <td>•</td> <td></td>	Serum calcium	SMD:17 (58, .23)	•			
Measles incidenceRR: 12 (.03, .38)HPV incidenceRR: .26 (.23, .30)Mumps incidenceRR: .96 (.42, .2.1)HPV prevalenceRR: .56 (.38, .82)Varicella deathsRR: .74 (.56, .98)HPVvaccine coverageRR: .1.76 (.1.73, 1.80)Meningococcal vaccine uptakeRR: .1.56 (1.45, .1.67)HPVuncine coverageRR: .1.76 (.1.73, 1.80)Meningococcal vaccine uptakeRR: .1.56 (1.45, .1.67)HPVuncine uptakeRR: .1.21 (1.20, 1.23)Rubella susceptibilityRR: .24 (.1.6, .36)HPVvaccine uptakeRR: .1.21 (1.20, 1.23)Rubella susceptibilityRR: .27 (.15, .46)Multivaccine coverageRR: .1.78 (1.41, 2.23)HPVincidence of genital wartsRR: .66 (.52, .84)Preventing substance abuse </td <td>Adolescent immunization</td> <td></td> <td></td> <td></td>	Adolescent immunization					
Mumps incidenceRR: 96 (42, 2.21)HPV prevalenceRR: .56 (.38, .82)Varicella deathsRR: 74 (.56, .98)HPV-vaccine coverageRR: 1.76 (.1.73, 1.80)Meningococcal vaccine uptakeRR: 1.56 (.1.45, 1.67)HPV-vaccine uptakeRR: .15 (.0.1, 2.46)Pertussis incidenceRR: .24 (.16, .36)HPV-vaccine uptakeRR: .121 (1.20, 1.23)Rubella susceptibilityRR: .27 (.15, .46)Multivaccine coverageRR: .178 (1.41, 2.23)HPVincidence of genital wartsRR: .66 (.52, .84)Preventing substance abuseSmoking uptake (pure prevention)RR: .88 [.82, .96]Frequency of drinking daysSMD: .07 [.02, .13]Regular smokingRR: .59 [.42, .83]Frequency of havy drinkingSMD: .07 [0.1, .14]Smoking at follow-upRR: .86 [.79, .94]Marijuana use (>12 months)RR: .83 [.69, .99](moke-free class competition)SMD: .13 [.64, .82]Hard drug use (>12 months)RR: .88 [.55, .62]Jacoho clonsumptionSMD: .13 [.07, .19]Cannabis useRR: .58 [.55, .62](quantity/week/month)SMD: .13 [.07, .19]Knowledge of suicide preventionSMD: .13 [.64, .62]Accident and injury preventionRR: .66 (.59, .73)Helmet useRR: .100 (.98, 1.02)Accident and injury preventionRR: .66 (.59, .73)Helmet useRR: .90 (.97, .00)Road accidentsRR: .81 (.78, .84)Seatbelt useRR: .90 (.97, .00)Road accidentsRR: .90 (.73, .86)Injuries per number of exposureRR: .90 (.70, .88)	Measles incidence	RR: .12 (.03, .38)	HPV incidence	RR: .26 (.23, .30)		
Varicella deathsRR: 74 (56, 98)HPV-vaccine coverageRR: 1.76 (1.73, 1.80)Meningococcal vaccine uptakeRR: 1.56 (1.45, 1.67)HPVCIN3 incidenceRR: 1.5 (01, 2.46)Pertussis incidenceRR: 24 (.16, 36)HPVvaccine uptakeRR: 1.21 (1.20, 1.23)Rubella susceptibilityRR: 2.7 (.15, .46)Multivaccine coverageRR: 1.78 (1.41, 2.23)HPVincidence of genital wartsRR: .66 (.52, .84)Rreventing substance abuseRR: .59 [.42, .83]Frequency of drinking daysSMD: .07 [.02, .13]Regular smokingRR: .59 [.42, .83]Frequency of heavy drinkingSMD: .07 [01, .14]Smoking at follow-upRR: .86 [.79, .94]Marijuana use (>12 months)RR: .83 [.69, .99](smoke-free class competition)II: fertime smokingRR: .79 [.61, .102]Cannabis useRR: .58 [.39, 1.90]Jochol consumptionSMD: .13 [.07, .19](quantity/week/month)RR: .58 [.55, .62]Alcohol consumptionSMD:	Mumps incidence	RR: .96 (.42, 2.21)	HPV prevalence	RR: .56 (.38, .82)		
Meningococcal vaccine uptakeRR: $1.56 (1.45, 1.67)$ HPV—CIN3 incidenceRR: $.15 (.01, 2.46)$ Pertussis incidenceRR: $.24 (.16, .36)$ HPV—vaccine uptakeRR: $1.21 (1.20, 1.23)$ Rubella susceptibilityRR: $.27 (.15, .46)$ Multivaccine coverageRR: $1.78 (1.41, 2.23)$ HPV—incidence of genital wartsRR: $.66 (.52, .84)$ Preventing substance abuseSMD: $.07 [.02, .13]$ Smoking uptake (pure prevention)RR: $.88 [.82, .96]$ Frequency of drinking daysSMD: $.07 [.02, .13]$ Regular smokingRR: $.59 [.42, .83]$ Frequency of heavy drinkingSMD: $.07 [.02, .13]$ smoking at follow-upRR: $.86 [.79, .94]$ Marijuana use (>12 months)RR: $.83 [.69, .99]$ (smoke-free class competition)Ifferime smokingRR: $.73 [.64, .82]$ Hard drug use (>12 months)RR: $.86 [.39, 1.90]$ 30-day smokingRR: $.79 [.61, 1.02]$ Cannabis useRR: $.58 [.55, .62]$ Alcohol consumptionSMD: $.13 [.07, .19]$ (quantity/week/month)Interventions for mental healthSMD: $.72 [.36, 1.07]$ DepressionSMD: $16 [26,05]$ AnxietySMD: $33 [59,06]$ Knowledge of suicideSMD: $1.51 [.57, 2.45]$ Accident and injury preventionRR: $.66 (.59, .73)$ Helmet useRR: $.100 (.98, 1.02)$ Road accidentsRR: $.81 (.78, .84)$ Seatbelt useRR: $.99 (.97, 1.00)$ Injuries per hour of exposureRR: $.79 (.73, .86)$ Injuries per number of exposureRR: $.79 (.70, .88)$	Varicella deaths	RR: .74 (.56, .98)	HPV—vaccine coverage	RR: 1.76 (1.73, 1.80)		
Pertussis incidenceRR: $.24$ (.16, .36)HPV—vaccine uptakeRR: 1.21 (1.20, 1.23)Rubella susceptibilityRR: $.27$ (.15, .46)Multivaccine coverageRR: 1.78 (1.41, 2.23)HPV—incidence of genital wartsRR: $.66$ (.52, .84)Multivaccine coverageRR: 1.78 (1.41, 2.23)Preventing substance abuseSMD: of [.02, .13]Regular smokingRR: $.59$ [.42, .83]Frequency of drinking daysSMD: $.07$ [.02, .13]Regular smokingRR: $.59$ [.42, .83]Frequency of heavy drinkingSMD: $.07$ [.02, .13]Smoking at follow-upRR: $.86$ [.79, .94]Marijuana use (>12 months)RR: $.83$ [.69, .99](smoke-free class competition)Ifetime smokingRR: $.73$ [.64, .82]Hard drug use (>12 months)RR: $.86$ [.39, 1.90]30-day smokingRR: $.79$ [.61, 1.02]Cannabis useRR: $.58$ [.55, .62]Alcohol consumptionSMD: $.13$ [.07, .19](quantity/week/month)Interventions for mental healthKnowledge of suicide preventionSMD: 16 [26 , 05]AnxietySMD: 33 [59 , 06]Knowledge of suicideSMD: 1.51 [.57, 2.45]Accident and injury preventionRR: $.66$ (.59, .73)Helmet useRR: $.99$ (.97, 1.00)Incidence of injuryRR: $.66$ (.59, .73)Helmet useRR: $.99$ (.97, 1.00)Injuries per hour of exposureRR: $.79$ (.70, .88)Injuries per number of exposureRR: $.79$ (.70, .88)	Meningococcal vaccine uptake	RR: 1.56 (1.45, 1.67)	HPV—CIN3 incidence	RR: .15 (.01, 2.46)		
Rubella susceptibilityRR: $27 (.15, .46)$ Multivaccine coverageRR: $1.78 (1.41, 2.23)$ HPV—incidence of genital wartsRR: $.66 (.52, .84)$ Frequency of drinking daysSMD: $.07 [.02, .13]$ Preventing substance abuseRR: $.88 [.82, .96]$ Frequency of heavy drinking daysSMD: $.07 [.02, .13]$ Smoking uptake (pure prevention)RR: $.88 [.82, .96]$ Frequency of heavy drinking daysSMD: $.07 [.02, .13]$ Regular smokingRR: $.59 [.42, .83]$ Frequency of heavy drinkingSMD: $.07 [01, .14]$ Smoking at follow-upRR: $.86 [.79, .94]$ Marijuana use (>12 months)RR: $.83 [.69, .99]$ (smoke-free class competition)RR: $.73 [.64, .82]$ Hard drug use (>12 months)RR: $.86 [.39, 1.90]$ 30 -day smokingRR: $.79 [.61, 1.02]$ Cannabis useRR: $.58 [.55, .62]$ Alcohol consumptionSMD: $.13 [.07, .19]$ (quantity/week/month)RR: $.58 [.55, .62]$ Interventions for mental healthKnowledge of suicide preventionSMD: $.72 [.36, 1.07]$ DepressionSMD: $16 [26,05]$ AnxietySMD: $33 [59,06]$ Knowledge of suicideSMD: $1.51 [.57, 2.45]$ Accident and injury preventionRR: $.66 (.59, .73)$ Helmet useRR: $1.00 (.98, 1.02)$ Road accidentsRR: $.81 (.78, .84)$ Seatbelt useRR: $.99 (.97, 1.00)$ Injuries per hour of exposureRR: $.79 (.70, .88)$ Injuries per number of exposureRR: $.79 (.70, .88)$	Pertussis incidence	RR: .24 (.16, .36)	HPV—vaccine uptake	RR: 1.21 (1.20, 1.23)		
HPV—incidence of genital wartsRR: .66 (.52, .84)Preventing substance abuseSMD: .07 [.02, .13]Smoking uptake (pure prevention)RR: .88 [.82, .96]Frequency of drinking daysSMD: .07 [.02, .13]Regular smokingRR: .59 [.42, .83]Frequency of heavy drinkingSMD: .07 [.02, .13]Smoking at follow-upRR: .59 [.42, .83]Frequency of heavy drinkingSMD: .07 [.02, .13]smoking at follow-upRR: .66 [.79, .94]Marijuana use (>12 months)RR: .83 [.69, .99](smoke-free class competition)Ifetime smokingRR: .73 [.64, .82]Hard drug use (>12 months)RR: .86 [.39, 1.90]30-day smokingRR: .79 [.61, 1.02]Cannabis useRR: .58 [.55, .62]Alcohol consumptionSMD: .13 [.07, .19](quantity/week/month)SMD: .72 [.36, 1.07]DepressionSMD: $16 [26,05]$ AnxietySMD: $33 [59,06]$ Knowledge of suicideSMD: $1.51 [.57, 2.45]$ Accident and injury preventionRR: .66 (.59, .73)Helmet useRR: 1.00 (.98, 1.02)Road accidentsRR: .81 (.78, .84)Seatbelt useRR: .99 (.97, 1.00)Injuries per hour of exposureRR: .79 (.73, .86)Injuries per number of exposureRR: .79 (.70, .88)	Rubella susceptibility	RR: .27 (.15, .46)	Multivaccine coverage	RR: 1.78 (1.41, 2.23)		
Preventing substance abuseFrequency of drinking daysSMD: .07 [.02, .13]Smoking uptake (pure prevention)RR: .88 [.82, .96]Frequency of heavy drinking daysSMD: .07 [.02, .13]Regular smokingRR: .59 [.42, .83]Frequency of heavy drinkingSMD: .07 [01, .14]Smoking at follow-upRR: .86 [.79, .94]Marijuana use (>12 months)RR: .83 [.69, .99](smoke-free class competition)(smoke-free class competition)RR: .73 [.64, .82]Hard drug use (>12 months)RR: .86 [.39, 1.90]30-day smokingRR: .79 [.61, 1.02]Cannabis useRR: .86 [.39, 1.90]RR: .58 [.55, .62]Alcohol consumptionSMD: .13 [.07, .19](quantity/week/month)RR: .58 [.55, .62]Interventions for mental healthSMD: .72 [.36, 1.07]DepressionSMD: $16 [26,05]$ AnxietySMD: $33 [59,06]$ Knowledge of suicideSMD: $1.51 [.57, 2.45]$ Accident and injury preventionRR: .66 (.59, .73)Helmet useRR: 1.00 (.98, 1.02)Road accidentsRR: .81 (.78, .84)Seatbelt useRR: .99 (.97, 1.00)Injuries per hour of exposureRR: .79 (.73, .86)Injuries per number of exposureRR: .79 (.70, .88)	HPV—incidence of genital warts	RR: .66 (.52, .84)				
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Anxiety SMD:33 [59,06] Knowledge of suicide SMD: 1.51 [.57, 2.45] Accident and injury prevention	Knowledge of suicide prevention	SMD: .72 [.36, 1.07]	Depression	SMD:16 [26,05]		
Accident and injury prevention RR: .66 (.59, .73) Helmet use RR: .1.00 (.98, 1.02) Road accidents RR: .81 (.78, .84) Seatbelt use RR: .99 (.97, 1.00) Injuries per hour of exposure RR: .79 (.73, .86) Injuries per number of exposure RR: .79 (.70, .88)	Anxiety	SMD:33 [59,06]	Knowledge of suicide	SMD: 1.51 [.57, 2.45]		
Incidence of injury RR: .66 (.59, .73) Helmet use RR: 1.00 (.98, 1.02) Road accidents RR: .81 (.78, .84) Seatbelt use RR: .99 (.97, 1.00) Injuries per hour of exposure RR: .79 (.73, .86) Injuries per number of exposure RR: .79 (.70, .88)	Accident and injury prevention					
Road accidents RR: .81 (.78, .84) Seatbelt use RR: .99 (.97, 1.00) Injuries per hour of exposure RR: .79 (.73, .86) Injuries per number of exposure RR: .79 (.70, .88)	Incidence of injury	RR: .66 (.59, .73)	Helmet use	RR: 1.00 (.98, 1.02)		
Injuries per hour of exposureRR: .79 (.73, .86)Injuries per number of exposureRR: .79 (.70, .88)	Road accidents	RR: .81 (.78, .84)	Seatbelt use	RR: .99 (.97, 1.00)		
	Injuries per hour of exposure	RR: .79 (.73, .86)	Injuries per number of exposure	RR: .79 (.70, .88)		

BMI = body mass index; CBT = cognitive behavioral therapy; CI = confidence interval; EAT = eating attitude test; EDI = eating disorder inventory; FGM/C = female genital mutilation/cutting; HPV = human papillomavirus; RR = relative risk; SATAQ = sociocultural attitudes toward appearance questionnaire; SMD = standard mean difference; STI = sexually transmitted infections.

Implications for Future Research

Future studies should specifically be targeted toward the LMIC to evaluate the effectiveness of adolescent health interventions in these settings. Further studies with longer term follow-ups are required, and study authors should use standardized and validated measurement instruments to maximize comparability of results. Assessment of effects by gender and socioeconomic status is important, and future studies should also take this into account, as there may be differences for certain interventions and this information would be valuable. As adolescent health is still an evolving area with many of their needs unmet, it would be important to carry out an exercise involving experts of adolescent health to prioritize research gaps and recommend immediate areas of action. In addition, to identify further gaps in evidence for adolescent health, this exercise can provide donors with a comprehensive view of projected importance and feasibility of investing in these research gaps along with an idea of the relative importance of the each research priority.

It is also important to recognize ideal delivery platforms that can augment the coverage of proven adolescent health-specific interventions and provide an opportunity to reach hard-to-reach and disadvantaged population groups. Figure 1 highlights the delivery platforms utilized for the various interventions reviewed in this series of papers. These platforms include schooland community-based delivery, use of communication and information technology, specialized health services (like clinics, health posts, health centers, and district hospitals), youth organizations, and financial incentives. These existing platforms could be utilized to make services "adolescent friendly," that is, these should be equipped to systematically respond to the barriers to service use that adolescents and service providers have identified. Within each platform, the focus, content, and organization of the services can vary. Existing evidence suggests that school-based programs have been utilized for improving knowledge of sexual

COMMUNITY BASED	SCHOOL BASED	PRIMARY CARE FACILITY/OUTREACH CLINICS	SOCIAL MEDIA	SOCIAL/FINANCIAL PROTECTION		
SEXUAL HEALTH EDUCATION						
DATING VIOLENCE PREVENTION						
MMN SUPPLEMENTATION						
PREVENT PRE-PREGNANCY OBESITY						
PREVENTING FGM/C		PREVENTING FGM/C				
	TEENAGE PREGNANCY PREVENTION					
	PROMOTE HEALTHY NUTRITION/ PREVENT OBESITY					
	VACCINATION					
	PREVENTING EATING DISORDERS					
	SUICIDE PREVENTION					
	PREVENTING SUBSTANCE ABUSE		PREVENTING SUBSTANCE ABUSE			
		TREATING DEPRESSION AND ANXIETY				

Figure 1. Existing evidence of adolescent health–specific interventions according to the delivery platforms utilized. FGM/C = female genital mutilation/cutting; MMN = multiple micronutrient supplementation.

abuse and self-protective behaviors [11], prevention of tobacco use [12,13], reducing aggressive behavior [14], nutrition education interventions, and physical activity programs [15,16]. However, there is no existing evidence to support the effectiveness of formulating and implementing policies aiming to prevent smoking initiation or improving nutrition in schools [17,18]. Community-based delivery platforms have been widely utilized for the promotion of maternal, newborn, and child health and are now widely recognized as an important strategy to deliver key maternal and child survival interventions and to reduce inequities [19,20]. These platforms can also be used to target adolescents to improve their health. In recent years, communication, information technology, and mass media have rapidly evolved into a platform that provides innovative opportunities for engaging youth, including disadvantaged and hardto-reach youth and those turned off by traditional health education approaches [21–26]. Despite widespread emphasis on youth centers as a strategy for encouraging young people to access sexual and reproductive health services, results from these studies have not been encouraging, and cost-effectiveness is likely to be low [27]. There is very limited and inconclusive evidence on effects of youth empowerment programs outside of formal education [28-30].

The World Health Organization and the United Nations Programme on HIV and AIDS have recently released global standards for quality health care services for adolescents to assist policy makers and health service planners in improving the quality of health care services so that the adolescents find it easier to obtain the health services that they need to promote, protect, and improve their health and well-being. These series, based on four volumes, focus on standards and criteria; implementation guide; tools to collect data; and scoring sheets for data analysis [3,31–33].

Recommendations and Conclusions

Compromised adolescent health will negatively affect a country's economy, which will be more pronounced in LMICs. Failure to invest in the health care of adolescents will further increase in the number of dependents in coming generations and negatively influence the health of future generations. It is therefore imperative to work toward improving adolescent health in order to ensure a brighter future for coming generations. Sustainable development goals provide an opportunity for renewed attention to meeting the health care needs of adolescents through the strengthening of health systems. This requires a specific focus on modes and channels of delivering targeted interventions via specialized health services (such as clinics, health posts, health centers, and district hospitals), school-based delivery, youth organizations, community-based delivery, information communication technology, and mass media. To make progress toward universal health coverage, ministries of health and the health sector more generally will need to transform how health systems respond to the health needs of adolescents. A number of transitions in service delivery, workforce capacity, and financing will be needed. Three types of interventions have been stated to be required for increasing the utilization of services by adolescents-some changes in the health facilities (or spot of service delivery), some changes in the attitudes of providers, and sensitization of the community gatekeepers (such as parents, teachers, and community opinion leaders) as to how access to services can help adolescents [34].

Acknowledgments

Authors' contributions: All authors contributed to finalizing the manuscript.

The preparation and publication of these papers was made possible through an unrestricted grant from the Bill & Melinda Gates Foundation (BMGF).

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