



Adolescent Girls' Nutritional Status and Knowledge, Beliefs, Practices, and Access to Services: An Assessment to Guide Intervention Design in Nepal

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ABSTRACT

Background: Despite growing recognition of the importance of the adolescent period for health and nutritional well-being, scant evidence exists to inform interventions. Beyond limited understanding of adolescents' knowledge and practices, gaps in adolescent research also include limited understanding of how best to reach them with programs and policies and how the contexts in which they live present barriers and opportunities. Given that most studies on adolescent health and nutrition have used data from surveys of women of reproductive age, this study also sought to understand variation among younger and older adolescents and those who were already mothers.

Objectives: The primary aim was to support the design of an evidence-based adolescent program (Suaahara) in Nepal by describing adolescent girls' nutritional status; their exposure to information and services, knowledge, and practices in nutrition, health, family planning, and water, sanitation, and hygiene (WASH); and contextual factors; and to quantify variation by stage of adolescence.

Methods: Using the first round (2017) from a panel of Nepalese adolescent girls, we categorized adolescent girls as: younger (10–14.9 y; $n = 512$), older (15–19.9 y; $n = 325$), and mothers (15–19.9 y; $n = 256$). Descriptive analyses generated proportions and means \pm SDs, with statistical significance testing of differences.

Results: The prevalence of underweight was highest in younger adolescents, whereas the prevalence of overweight/obesity in mothers was double that of the other 2 groups. More younger adolescents were in school, but fewer owned a mobile phone or had radio access. Exposure, knowledge, and behaviors across thematic areas also differed by stage of adolescence.

Conclusions: These findings have implications for Suaahara and other programs and policies aiming to support the health and nutritional well-being of adolescent girls. Heterogeneity among adolescent girls should be considered when identifying which interventions are needed and have the most potential for each subpopulation. *Curr Dev Nutr* 2020;4:nzaa094.

Keywords: adolescent nutrition, adolescent health, Nepal, implementation science, school programs, implementation research, formative research, water, sanitation, and hygiene

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Manuscript received March 25, 2020. Initial review completed May 20, 2020. Revision accepted May 21, 2020. Published online May 23, 2020.

This study was funded by the United States Agency for International Development (USAID) under a Cooperative Agreement (No. AID-367-A-16-00006) between USAID and Helen Keller International.

Data are not yet deposited in the public domain in any repository but will be uploaded to USAID's open data repository by March 2021.

Author disclosures: The authors report no conflicts of interest. The contents of this article are the sole responsibility of the authors and do not necessarily reflect the views of USAID or the US government.

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Abbreviations used: AM, adolescent mother; BAZ, body mass index for age z-score; DDS, dietary diversity score; DHS, Demographic and Health Surveys; FP, family planning; IFA, iron and folic acid; LMIC, low- and middle-income countries; MDD, minimum dietary diversity; MDD-W, minimum dietary diversity for women; OAG, older adolescent girl; SII, Suaahara II; SPRING, Strengthening Partnerships, Results, and Innovations in Nutrition Globally; SSB, sugar-sweetened beverage; WASH, water, sanitation, and hygiene; YAG, younger adolescent girl.

Introduction

The world's current adolescent cohort (10–19 y) is the largest in human history, 90% of whom live in low- and middle-income countries (LMIC) (1). The need to tailor policies and programs to meet their unique needs is now recognized. Health and nutrition interventions should optimize this period of growth and development to

promote intergenerational health (2, 3). The health and well-being of adolescent girls must be protected not only for themselves but also so that healthy adolescent girls can become healthy mothers of healthy children. Because of the adolescent growth spurt, nutrient requirements during adolescence increase. There is also some evidence suggesting that “catch-up” growth is possible during adolescence if nutrition is adequate (3–5). Adolescence is therefore a second

window of opportunity to lay the foundation for health across the life course.

The recently developed Strengthening Partnerships, Results, and Innovations in Nutrition Globally (SPRING) conceptual framework makes explicit individual-, household-, community-, and society-level determinants of adolescent nutritional status (6). Immediate determinants of nutritional status include the individual's diet, physical activity, morbidity, and early pregnancy, which are shaped by the individual's access to and use of quality services; knowledge, attitudes, and practices; and other individual characteristics (e.g., physical and emotional health, school attendance, peer networks, and empowerment). Household factors, such as sociodemographic and economic status, also play a role, as do community factors including land availability and customs. Furthermore, societal-level forces such as the sociocultural, economic, geographic, and political contexts, and the macro food environment, underpin all these determinants. Currently, the Demographic and Health Surveys (DHS) are most commonly used to describe adolescent girls' health and nutrition, but younger adolescent girls (10–14 y) are not included. Few datasets include both younger and older adolescents and even fewer comprehensively capture the range of factors in the SPRING framework. Additional data gaps relate to adolescents' current level of knowledge to inform the starting point for programs and policies, as well as evidence of which intervention platforms would best reach adolescents at different stages of adolescence. These identified data gaps have spurred recent calls for investments in adolescent-specific nutrition-related data collection (7–9).

This study provides a detailed description of adolescent girls' exposure to information and services, knowledge and practices related to nutrition, health, family planning (FP), water, sanitation, and hygiene (WASH), and related contextual factors, and assesses variation in these factors by stage of adolescence: younger (10–14 y), older (15–19 y), and mothers (15–19 y and with a child) in Nepal.

Methods

Study context and sampling

A large-scale integrated nutrition program in Nepal, funded by the United States Agency for International Development and known as Suaahara II (SII), has an adolescent-focused learning agenda. To design and implement evidence-based interventions for adolescent girls and, in turn, learn lessons from our experiences, was challenging given data gaps in Nepal and globally. The team decided, therefore, to build into the monitoring system, data collection specifically targeting adolescent girls. Data were collected for the first cross-sectional annual monitoring survey in the rainy season (June–September) of 2017. A multi-stage cluster sampling approach using probability proportional to size was utilized to select 3648 households residing in SII intervention areas: districts ($n = 16$), municipalities ($n = 32$), wards ($n = 96$), and clusters ($n = 192$). Within each cluster, following a complete census, households with children aged <5 y were randomly selected. Within these households, the mother and a major household decision-maker (male, when available) were interviewed. Given the additional objective of generating data to design interventions for adolescent girls, if an adolescent girl resided in the household and was available ($n = 837$), she was also selected for interview. If >1 adolescent girl resided in the household, 1 was

randomly selected for inclusion. The list of randomly sampled mothers who were of adolescent age (15–19 y, $n = 256$) was combined with the list of the 837 randomly sampled adolescent girls to form the adolescent girls' cohort ($n = 1093$) to be followed annually. The response rate was 100% because there were no refusals to respond to the survey; 4 of the adolescents refused for their anthropometrics to be measured.

All survey tools were drafted in English, translated into Nepali, back translated, and pretested prior to data collection. Data were collected electronically using smartphones. In addition to survey modules on household socioeconomic and demographic characteristics and a host of factors at all levels of the conceptual framework detailed above, anemia was tested by measuring hemoglobin concentrations, using HemoCue Hb-301 photometers. Anthropometric measurements were collected by standardized female enumerators. Height was measured twice using standard height-measuring boards (ShorrBoard). Weight was measured once using a lightweight electronic SECA digital scale (UNICEF Electronic Scale or Uniscale).

Ethical approval for this study was obtained from the Nepal Health Research Council. Written informed consent and assent of a responsible adult, when a minor (<18 y) was surveyed, were obtained prior to interviews.

Measures and variables

We categorized adolescent girls by stage of adolescence: younger adolescents (YAGs) (10–14.9 y; $n = 512$), older adolescent girls (OAGs) (15–19.9 y; $n = 325$), and adolescent mothers (AMs) (15–19.9 y; $n = 256$). These age groupings are based on the WHO definition and what has previously been used in the literature, to facilitate comparison of our findings with other adolescent studies (2, 10, 11). Selection of variables for analysis was guided by the aforementioned framework and what was available in the dataset (Figure 1) (6).

Adolescent nutritional status indicators included: BMI, BMI for age z -scores (BAZ), and the prevalence of underweight and overweight/obesity. BMI was calculated using the weight measurement and the mean of height measurements acquired, after which z -scores were constructed (12), using the 2007 WHO growth reference (13). After excluding adolescents who were pregnant ($n = 27$), who withheld consent to be measured ($n = 4$), or whose measurements were biologically implausible ($BAZ = -7.15$ SD; $n = 1$), both BMI and BAZ were normally distributed.

Among the immediate determinants of adolescent nutritional status (6), we assessed current pregnancy status by self-report and asked AMs to give their age at their first pregnancy. A 24-h time diary, modeled on the Women's Empowerment in Agriculture Index, was used to assess physical labor (14). A qualitative 24-h dietary recall was administered. Individual dietary diversity scores (DDS) and whether each adolescent girl obtained minimum dietary diversity (MDD) were calculated using the Minimum Dietary Diversity for Women (MDD-W) guidelines (15). Consumption prevalence of snack foods and sugar-sweetened beverages (SSBs) in the previous 24 h was calculated. In this study, "snack foods" were defined as foods that are typically energy dense and nutrient poor and often are commercially produced, rather than based on time of consumption (16).

Individual-level nutritional status determinants measured included asking the adolescent girls whether they had heard of and ever visited a government health facility designed explicitly to provide a friendly

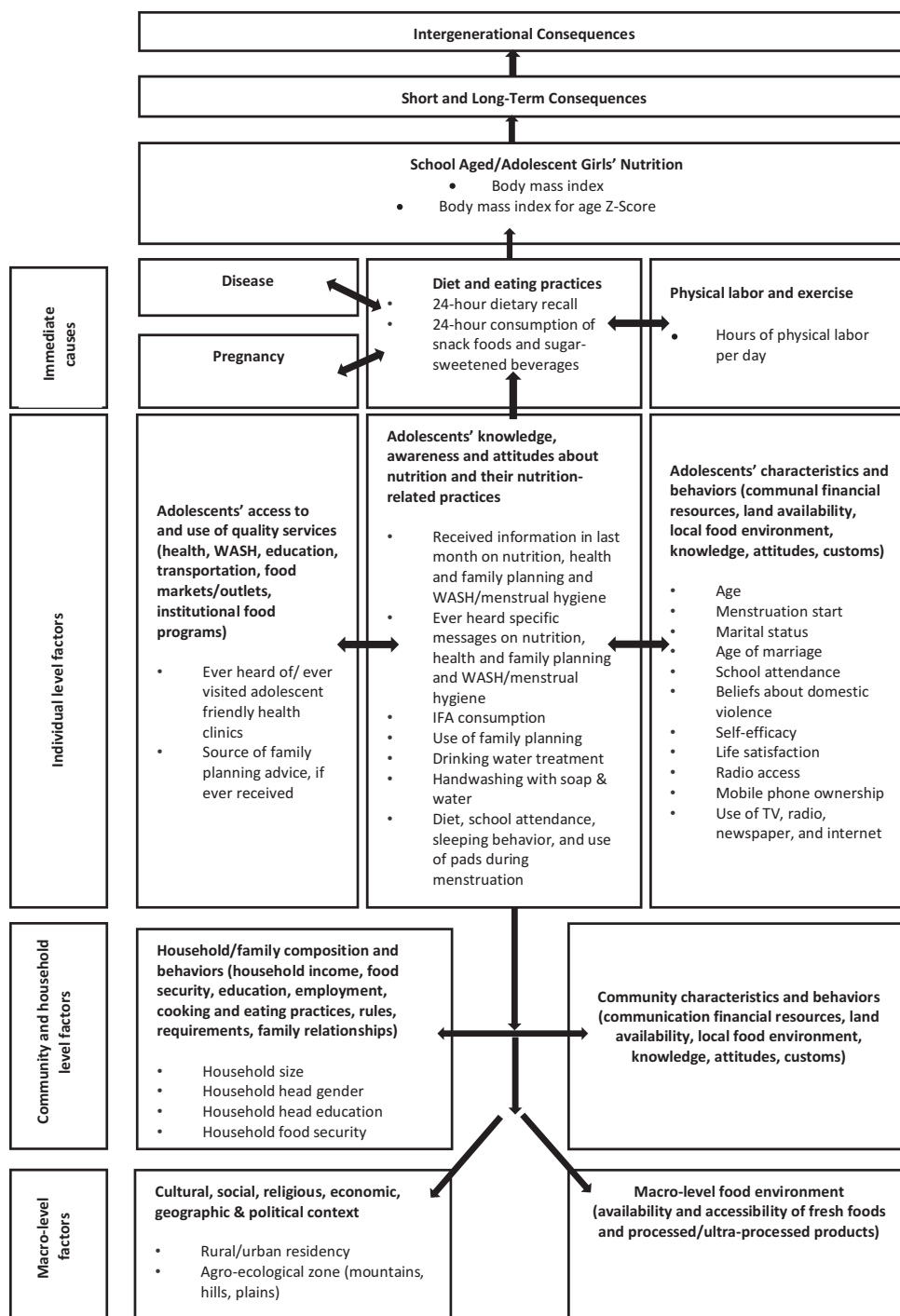


FIGURE 1 Conceptual framework for adolescent nutrition and Suaahara II adolescent data. IFA, iron and folic acid; WASH, water, sanitation, and hygiene. Adapted from reference 10.

welcome, convenient service hours, privacy and confidentiality, and other characteristics to facilitate easy access and utilization of services by adolescents, known in Nepal as adolescent-friendly health clinics (17). Furthermore, adolescent girls were asked whether they had ever received FP advice from any source, including adolescent-friendly health clinics, family, friends, or teachers. Knowledge, awareness, and

practices related to various nutrition, health/FP, and WASH topics were measured. Awareness was assessed by asking whether they had received any nutrition, health/FP, or WASH information in the last month from any mass media source and whether they had ever heard specific messages. To assess knowledge, we posed open-ended questions related to appropriate age of marriage for both boys and girls; appropriate age of

TABLE 1 Nutritional status among adolescent girls in Nepal, surveyed in 2017¹

	Younger adolescents (10–14 y)(n = 506)	Older adolescents (15–19 y)(n = 309)	Adolescent mothers (15–19 y)(n = 247)	P value
BMI, ² kg/m ²	16.5 ± 2.4	19.5 ± 2.4	20.7 ± 2.7	<0.001
BMI-for-age z-score ² (BAZ)	−0.87 ± 1.04	−0.59 ± 0.92	−0.28 ± 0.91	<0.001
BMI-for-age categories, %				<0.001
Severe thinness (≤−3 SD)	2.2	1.0	0	
Moderate thinness (≤−2 SD)	11.1	6.8	3.6	
Mild thinness (≤−1 SD)	31.8	20.4	15.0	
Normal	51.8	68.9	72.9	
Overweight (≥1 SD)	2.6	2.6	7.7	
Obese (≥2 SD)	0.6	0.3	0.8	
WHO underweight (BAZ ≤−1 SD)	45.1	28.2	18.6	<0.001
WHO overweight/obesity (BAZ ≥1 SD)	3.2	2.9	8.5	0.003
Anemic (n = 500, 308, 255)	17.0	27.3	28.6	<0.001

¹All currently pregnant were excluded from this table (n = 6, 16, 9).

²Values for BMI and BMI-for-age z-score are mean ± SD.

first pregnancy; and recommended months between childbirth and next pregnancy. We also asked the adolescent girls to name methods for modern FP and proper treatment of drinking water; for these 2 knowledge questions, binary variables to denote those who gave only correct compared with any incorrect responses were created. Further, we asked the adolescent girl to self-report if she had taken any iron and folic acid (IFA) tablets in the last few months. FP practices were assessed by asking married adolescent girls whether they adopted methods to delay/avoid pregnancy and if so, what they were. To assess WASH practices, an open-ended question was used to elicit responses about specific times when the individual washes her hands with soap. Menstrual hygiene practices were investigated by asking questions about where the subject sleeps, her school attendance, and food avoidance during menstruation.

Individual-level characteristics measured included age (in completed years); whether menstruation had started; marital status and, if married, age of marriage; and current school participation (or last grade attended). Attitudes toward domestic violence were assessed using the standard DHS module, which shares specific scenarios and asks whether a husband is justified in hitting his wife; a binary variable was created as having said yes to any (compared with none) of the 6 scenarios. Self-efficacy was assessed by asking the subject how much she agreed, using a 5-point Likert scale, to 8 statements about her ability to achieve her goals. Each girl's mean self-efficacy was calculated, and she was categorized as having below average (1–2), average (3), or above average (4–5) self-efficacy. Access to radio and mobile phone ownership was assessed. Exposure to television, radio, newspaper, and internet was assessed and binary variables created to categorize those with at least monthly compared with less than monthly exposure.

The household-level characteristics assessed included the number of household members, the household head's gender and years of formal schooling, and food security (based on the Household Food Insecurity Access Scale) (18). Among the cultural, social, religious, economic, geographic, and political factors, we assessed caste/ethnicity and socioeconomic well-being using the Equity Tool (www.equitytool.org), a validated tool for capturing socioeconomic wealth relative to the national population using variables from the most recent DHS survey. Geographic factors included rural or urban residency, as per Nepal's new

2017 classifications, and agroecological zone of residency [mountains, hills, and *terai* (lowlands)].

Statistical analyses

Descriptive analyses were conducted for the 3 groupings of adolescent girls. Proportions and means ± SDs were calculated to describe the sample. Two-sided Pearson chi-square tests were used to test differences in proportions, and independent sample *t* tests for differences in means, all adjusted for clustering. All data analyses were performed using Stata 15 (StatCorp LLC).

Results

During this survey of 3642 households, 7% (n = 256) of mothers were adolescents (15–19 y). Additionally, an adolescent girl (10–19 y) resided in and was available for interview in 23% (n = 837) of the households; this included 512 YAGs and 325 OAGs. All 1093 were included in the analysis, except for calculation of nutritional status in which 31 individuals were excluded as previously described.

Nutritional status

Table 1 shows the nutritional status of the sampled adolescent girls. YAGs had the highest prevalence of underweight (45%) and the lowest prevalence of overweight (3%). Conversely, AMs had the lowest prevalence of underweight (19%) and the highest prevalence of overweight (9%). The prevalence of anemia was higher (*P* < 0.001) in AMs (29%) and OAGs (27%) than in YAGs (17%) (**Table 1**).

Immediate determinants

We explored pregnancy, physical labor, and dietary differences among the 3 groups (**Table 2**). Only 1% of YAGs and 5% of OAGs reported being pregnant currently. The number of hours per day spent in physical labor varied significantly (YAGs: 4.0 ± 3.2 h; OAGs: 6.1 ± 3.9 h; AMs: 6.7 ± 3.3 h; *P* < 0.001). The average DDS and the prevalence of meeting MDD (≥5 of 10 food groups) was similar across the groups (YAGs: 31%; OAGs: 39%; AMs: 32%; *P* = 0.057). The prevalence of snack food consumption, however, was higher among YAGs than OAGs and AMs for

TABLE 2 Immediate determinants of nutritional status among adolescent girls in Nepal, surveyed in 2017¹

	Younger adolescents (10–14 y)(n = 512)	Older adolescents (15–19 y)(n = 325)	Adolescent mothers (15–19 y)(n = 256)	P value
Pregnancy				
Ever pregnant, %	NA	6.8	100.0	<0.001
Physical labor and exercise				
Hours of physical labor per day ²	4.0 ± 3.2	6.1 ± 3.9	6.7 ± 3.3	<0.001
Diet and eating practices				
Individual dietary diversity score (10FG) ²	4.0 ± 1.2	4.2 ± 1.2	4.0 ± 1.2	0.002
Minimum dietary diversity (5/10FG), %	31.2	39.1	32.4	0.456
Consumption of specific food groups, %				
Grains, white roots and tubers, and plantains	100.0	100.0	100.0	NA
Pulses (beans, lentils)	72.1	73.2	74.2	0.557
Nuts and seeds	2.7	5.9	3.9	0.143
Dairy	26.2	32.9	26.9	0.541
Meat, poultry, and fish	25.8	26.5	33.2	0.054
Eggs	2.3	3.4	7.8	0.002
Dark-green leafy vegetables	41.8	40.6	40.6	0.709
Vitamin A-rich fruits and vegetables	9.2	12.0	6.3	0.377
Other vegetables	83.6	90.5	84.4	0.417
Other fruits	32.6	40.3	26.9	0.331
Vegetarian diet followed, %	4.1	5.8	1.6	0.154
Consumption of snack foods and sugar-sweetened beverages, %				
Sweet snack foods	27.1	19.4	11.3	<0.001
Savory snack foods (other than instant noodles)	36.1	27.1	25.8	0.003
Instant noodles	29.7	23.7	17.2	0.001
Sugar-sweetened beverages	4.9	6.5	3.9	0.744
Any snack food or sugar-sweetened beverage	60.5	49.5	41.0	<0.001

¹FG, food groups; NA, data not collected for this group of adolescents.

²Values are mean ± SD.

all 3 types of snack foods: sweet snack foods (YAGs: 27%; OAGs: 19%; AMs: 11%; $P < 0.001$); savory snack foods (YAGs: 36%; OAGs: 27%; AMs: 26%; $P = 0.003$); and instant noodles (YAGs: 30%; OAGs: 24%; AMs: 17%; $P < 0.001$). There was, however, no statistically significant difference between the 3 groups' SSB consumption prevalence, which ranged from 4% to 6%.

Intermediate determinants

Knowledge, awareness, and practices are grouped by theme: nutrition, health/FP, and WASH (Table 3). Having ever heard of government-provided adolescent-friendly health clinics was low (YAGs: 13%; OAGs: 24%; AMs: 11%; $P = 0.935$) and not even 1 in 20 across any of the adolescent girl groups had ever visited these clinics. The variation in having ever received FP advice was substantial among the 3 groups (YAGs: 22%; OAGs: 46%; AMs: 63%; $P < 0.001$).

Exposure to nutrition information in the month prior to the survey was low (YAGs: 26%; OAGs: 38%; AMs: 28%; $P = 0.198$). The prevalence of YAGs having any exposure to the 2 prenatal nutrition messages was 25 to 35 percentage points below that of OAGs and AMs ($P < 0.001$), as one would expect. Almost no YAGs and OAGs had taken IFA, compared with a small proportion of AMs (YAGs: 2%; OAGs: 5%; AMs: 17%; $P < 0.001$).

Health and FP exposure in the month before the survey was lowest among YAGs (YAGs: 20%; OAGs: 39%; AMs: 39%; $P < 0.001$) and a much smaller proportion of YAGs reported exposure to messages on ways to delay/avoid pregnancy (YAGs: 32%; OAGs: 84%; AMs: 96%; $P < 0.001$). Nearly all had heard that marriage should be avoided until age

18 y (YAGs: 83%; OAGs: 97%; AMs: 98%; $P < 0.001$). Knowledge on FP methods was almost universal for AMs and OAGs, but low among YAGs (YAGs: 35%; OAGs: 85%; AMs: 99%; $P < 0.001$). Accurate knowledge of healthy timing and spacing of pregnancies and births was low among all 3 groups of adolescent girls. Across all 3 groups of adolescents, the appropriate age for marriage was reported as 22–23 y for boys and 20 y for girls. There was not a big difference in the percentage of those doing anything to delay/avoid pregnancy and those using a modern method; on average it was 1 in 5 OAGs and 1 in 3 to 4 AMs. Most adolescent girls who were married and reported not using any method of FP reported that their husband had emigrated and was not living at home as the main reason.

Receipt of WASH information in the month before the survey was low among all adolescent groups (YAGs: 31%; OAGs: 41%; AMs: 23%; $P = 0.165$). Knowledge of appropriate drinking water treatment methods was poor, with fewer than half in each group naming only correct methods. Always handwashing with soap and water after defecation was $\geq 95\%$ for all 3 groups, but for the other 5 critical handwashing times, the prevalence was lower for YAGs than either OAGs or AMs. Few adolescents had heard messages about menstrual hygiene practices, with exposure to such messages particularly low among YAGs. During menstruation, nearly all in-school girls reported continuing attending school, approximately one-third reported using a commercial/disposable pad, about 4 of 5 reported sleeping in their own bed, and $< 10\%$ avoided certain foods.

Individual-level characteristics also differed across the 3 groups of adolescents. About 1 in 5 OAGs were married, and among both the OAG

TABLE 3 Individual-level determinants of nutritional status among adolescent girls in Nepal, surveyed in 2017¹

	Younger adolescents (10–14 y)(n = 512)	Older adolescents (15–19 y)(n = 325)	Adolescent mothers (15–19 y)(n = 256)	P value
Access to and use of quality services, %				
Ever heard of an adolescent-friendly health clinic	13.3	24.0	10.9	0.935
Ever visited an adolescent-friendly health clinic	1.9	3.4	1.2	0.684
Ever received family planning advice (from any source)	21.7	45.6	62.9	<0.001
Knowledge, awareness, attitudes, and practices				
<i>Nutrition, %</i>				
Received nutrition information in last month from TV, radio, brochure, etc.	26.2	37.5	28.1	0.198
Pregnant and lactating women should eat more food, and consume animal source foods: ever heard	49.2	83.1	89.1	<0.001
Pregnant women should take 180 iron and folic acid (IFA) tablets: ever heard	16.0	44.3	76.9	<0.001
Took iron and folic acid tablet in last 13 weeks	2.1	4.6	16.8	<0.001
<i>Health and family planning, %</i>				
Received health/family planning information in last month from TV, radio, brochure, etc.	19.9	38.8	38.7	<0.001
Pregnant women should attend at least 4 ANC visits: ever heard	36.9	79.1	92.6	<0.001
Modern methods of family planning should be used to delay or avoid pregnancy: ever heard	31.6	83.7	95.7	<0.001
Girls should avoid marriage until at least 18 years of age: ever heard	82.6	97.2	97.7	<0.001
Able to name a modern method of family planning	34.2	83.7	95.7	<0.001
Recommended age for marriage: boys ²	22.0 ± 2.6	23.2 ± 2.6	22.8 ± 2.2	<0.001
Recommended age for marriage: girls ²	20.3 ± 1.8	20.4 ± 1.7	20.2 ± 1.5	0.614
Recommended months between giving birth and becoming pregnant again (24 mo)	15.0	9.9	7.8	0.003
Currently doing anything to delay/avoid pregnancy	NA	20.0	30.6	0.137 ³
Currently using modern method of family planning	NA	18.0	26.9	0.184 ³
Among those not using any (n = NA, 40, 170): husband migrated	NA	47.5	77.6	<0.001 ³
<i>WASH and menstrual hygiene, %</i>				
Received water, sanitation, and hygiene information in last month from TV, radio, brochure, etc.	31.2	40.6	23.4	0.165
Water should be treated by boiling, SODIS, water filter, or similar method regularly before drinking: ever heard	84.4	95.1	91.4	<0.001
Hands should be washed with soap and water before cooking and preparing food: ever heard	93.0	98.1	95.3	0.100
Importance of changing one's cloth or pad at least every 7 hours: ever heard	34.2	35.4	66.4	<0.001
Importance of using a clean cloth or pad, including washing it with soap and water: ever heard	53.9	87.1	85.2	<0.001
Drinking water treatment method: any appropriate (boiling, filter, chlorine, or SODIS) method and no incorrect methods	43.7	40.6	38.7	0.173
Handwashing with soap and water always (open ended), %				
After defecation	95.1	96.0	97.3	0.175
After cleaning a young child's bottom	12.9	18.1	80.1	<0.001
After handling livestock/animals	47.3	64.6	53.5	0.014
Before cooking/preparing food	12.3	23.1	18.0	0.004
Before eating	64.6	70.5	48.8	0.002
Before feeding children	2.7	3.4	25.8	<0.001
Uses commercial/disposable pad during menstruation (n = 153, 314, 256)	32.0	28.7	27.7	0.393
Sleeps in own bed during menstruation (n = 153, 314, 256)	58.2	58.3	60.5	0.557
Avoids certain foods during menstruation (n = 153, 314, 256)	8.5	7.6	5.9	0.311
Attends school during menstruation, among those in school and started menstruating (n = 146, 221, 8)	93.8	92.3	100.0	0.814
Characteristics and behavior				
Age (completed years) ²	11.9 ± 1.4	16.7 ± 1.4	18.1 ± 0.9	<0.001
Menstruation started, %	29.9	96.6	100.0	<0.001
Currently married, %	NA	20.6	100	<0.001 ³
Age at first marriage, among those married (n = 0, 67, 256) ²	NA	16.2 ± 1.4	15.7 ± 1.2	0.007 ³
Age at first pregnancy, among those ever pregnant (n = 0, 0, 256) ²	NA	NA	16.4 ± 1.2	NA
Currently at school/university or completed grade 10, %	97.3	73.2	17.2	<0.001
Agrees husband is justified in hitting/beating wife (at least 1/5 scenarios), %	21.7	19.4	23.4	0.702
Self-efficacy: above average or high, %	33.8	43.7	41.8	0.007

(Continued)

TABLE 3 (Continued)

	Younger adolescents (10–14 y)(n = 512)	Older adolescents (15–19 y)(n = 325)	Adolescent mothers (15–19 y)(n = 256)	P value
Life satisfaction: satisfied or very satisfied, %	91.8	86.5	81.6	<0.001
Individual radio access, %	47.8	68.0	80.9	<0.001
Individual mobile phone ownership, %	6.4	56.6	70.0	<0.001
Uses at least monthly, %				
Television	53.5	52.6	43.7	0.035
Radio	43.9	64.3	50.4	0.005
Newspaper	4.3	13.2	0.8	0.349
Internet	2.3	20.3	28.1	<0.001

¹ANC, antenatal care; IFA, iron and folic acid; NA, data not collected for this group of adolescents; SODIS, solar disinfection; WASH, water, sanitation, and hygiene.

²Values are mean \pm SD.

³The statistical test of differences in proportions and means was between results for older adolescent girls and adolescent mothers only.

and AM groups the mean age of marriage was 16 y. Although nearly all YAGs were currently in school and 85% of OAGs were currently in school or had graduated from secondary school, only 3% of AMs were either still in school or had graduated ($P < 0.001$). In all 3 groups of adolescents, at least 1 in 5 agreed that a husband is justified in beating his wife in at least 1 of 6 scenarios presented. The prevalence of having a higher than average self-efficacy score was lower among YAGs (34%) than among OAGs (45%) and AMs (42%) ($P = 0.007$).

YAGs had the least access to radios and mobile phones; more AMs than either YAGs or OAGs had access to a radio (YAGs: 48%; OAGs: 68%; AMs: 81%; $P < 0.001$) and reported owning their own mobile phone (YAGs: 7%; OAGs: 57%; AMs: 70%; $P < 0.001$). Similarly, only 2% of YAGs compared with 20% of OAGs and 28% of AMs ($P < 0.001$) used the internet monthly. For all 3 groups, among information sources used at least monthly, radio and television were cited most frequently.

Underlying determinants

Household-level characteristics and other contextual factors (Table 4) create an enabling environment for adolescent well-being. Most of these factors did not vary across the 3 adolescent groups, although there were some exceptions, such as average number of household members (YAGs: 6; OAGs: 7; AMs: 5; $P < 0.001$) and caste/ethnicity, with more AMs belonging to socially excluded groups (YAGs: 49%; OAGs: 47%; AMs: 57%; $P = 0.023$).

Discussion

In this study aiming to inform the design and implementation of interventions for adolescent girls in Nepal, we found their exposure, knowledge, and behaviors related to nutrition, health and FP, and WASH differed based on stage of adolescence (younger, older, and mother), as did the contextual factors that shape their lives and nutritional status. YAGs were most likely to be underweight, whereas AMs and OAGs were most likely to be anemic. We did not, however, find differences in dietary diversity. YAGs consistently had lower levels of exposure to information and key messages on nutrition, health and FP, and WASH; their knowledge and practices were usually poorer as well. More YAGs were currently in school and reported being satisfied with their current life situation than OAGs and AMs, although they had lower self-efficacy scores.

AMs had both greater access to radios and ownership of mobile phones than either YAGs or OAGs. These findings suggest that those planning adolescent-focused interventions must pay careful attention to heterogeneity and the differing potential for each intervention and channel to reach adolescents in different stages.

The nutritional status results among OAGs (15–19 y), and particularly adolescent mothers, in our survey are consistent with the most recent Nepal DHS (19). For the first time in Nepal's history, the proportion of overweight and obese women surpassed the proportion of underweight (19). Using the WHO BAZ, our study shows overweight to be of concern among the adolescent girls who have become mothers, although the prevalence was still low. Research in the United States has identified pregnancy in adolescence as a risk for overweight, whereas in Bangladesh researchers found that childbearing adolescents lost weight as both fat and lean body mass compared with never-pregnant peers matched by age and time since menarche (20). The consequences for the adolescents' own health now, their health and nutritional well-being in the future, and the health and nutritional well-being of their offspring, should they become mothers, are well documented. Pregnancies before age 18 y are at increased risk for small-for-gestational age and preterm births as well as neonatal and infant mortality (21). In low-resource settings early pregnancies have been found to halt adolescent growth and deplete fat and lean body mass (20). Early childbearing is also associated with school drop-out and reduced life opportunities (22). Nutrition programs therefore should include interventions to delay pregnancy given early pregnancy's adverse impact on maternal and child health and nutrition outcomes (20, 23). Our finding that nearly half of YAGs are too thin for their age supports recent global reviews that undernutrition persists as a larger burden than overnutrition in South Asia among adolescents (24, 25). We also found a larger SD for BAZ for the YAGs than OAGs, reflecting variability of weight-height relations during this period of sexual maturation. Accurate use and interpretation of BMI and BAZ for adolescents can be affected by the timing of growth spurts, menarche, and variations in adiposity levels across ethnic groups (26). More research is needed on the use of anthropometric measurements during adolescence, as well as studies on nutritional status among younger adolescent girls (aged 10–14 y) in LMIC. Nevertheless, these results suggest that policies and programs in Nepal should focus not only on undernutrition but also on overnutrition, as well as challenges related to the double and triple burdens of malnutrition, all having important consequence for the life course (27).

TABLE 4 Household- and community-level determinants of nutritional status among adolescent girls in Nepal, surveyed in 2017

	Younger adolescents (10–14 y)(n = 512)	Older adolescents (15–19 y)(n = 325)	Adolescent mothers (15–19 y)(n = 256)	P value
Household/family composition and behaviors				
Number of household members ¹	6.2 ± 2.6	7.1 ± 2.7	5.1 ± 2.2	<0.001
Household head: male, %	50.6	60.9	46.1	0.615
Household head education level completed, %				0.198
No education/some primary	42.6	44.0	42.6	
Primary completed (grades 1–8)	36.9	40.0	43.7	
Secondary (grade 9) completed or above	20.5	16.0	13.7	
Food insecurity level, %				0.166
Secure	59.8	62.1	62.5	
Mildly insecure	18.5	21.2	20.7	
Moderately insecure	19.0	14.2	14.1	
Severely insecure	2.7	2.5	2.7	
Equity quintile, %				0.930
Lowest	25.4	24.0	21.9	
Second lowest	31.4	27.4	33.6	
Middle	20.3	24.9	22.7	
Second highest	17.0	20.0	20.3	
Highest	5.9	3.7	1.6	
Caste/ethnicity, %				0.023
Socially excluded	49.4	47.4	57.0	
Brahmin/Chhetri	37.1	43.7	35.2	
Other	13.5	8.9	7.8	
Cultural, social, religious, economic, geographic, and political context, %				
Rural residency	47.5	52.3	45.3	0.835
Agroecological zone of residency				0.802
Mountains	14.7	16.9	10.9	
Hills	52.3	51.4	57.4	
Terai (lowland)	33.0	31.7	31.6	

¹Values are mean ± SD.

The finding that anemia is highest in adolescent mothers is consistent with a recently published study of predictors of adolescent anemia in Nepal, using the Nepal National Micronutrient Status Survey 2016 data, which also found younger age to be associated with reduced odds of anemia (28). These analyses also found that being from socially excluded caste groups was a risk factor for anemia. In our sample, adolescent mothers were more likely to belong to a socially excluded caste group, which could help to explain our findings. Furthermore, only 1 in 3 of the younger adolescents had started menstruating, whereas nearly all the adolescent mothers were still lactating and potentially still recovering from maternal iron depletion.

Diet quality among all adolescent groups was a concern: only ~1 in 3 adolescent girls in this study population met the cut-off for minimum dietary diversity, as per the MDD-W, whereas snack food consumption and underweight were higher in young adolescents. Although MDD-W has only been validated for women of reproductive age, there is not currently a validated measure for assessing diets of YAGs (15). This finding of dietary diversity being similar among the 3 groups of adolescents, but the prevalence of snack food consumption and underweight being more prevalent among younger adolescents, could be counterintuitive to some. Quantitative dietary recall data are needed to understand how much food is being consumed in each of these categories at each stage of adolescence. Data on other important contributors to undernutrition, including the adolescents' current and past health status, could also help to interpret these findings. Similarly, there is no validated measurement of the consumption of snack foods and SSBs, but our finding that half

of OAGs and even more YAGs consumed processed, unhealthy snack foods in the previous day is alarming and consistent with emerging data in Nepal regarding the prominence of unhealthy diets (16). The finding that >1 in 3 adolescent girls reside in food-insecure households indicates that policies and programs designed to tackle adolescent undernutrition must also address food access and availability. Schools can be an ideal platform for reaching adolescents to influence knowledge and practice, but there is yet insufficient evidence on the effectiveness of school gardens and other interventions, particularly at scale, for improving adolescent dietary behaviors (23).

Barely any YAGs and OAGs reported consuming IFA, which according to Nepal's School Health and Nutrition Programme should be distributed at school. This could be due to a variety of supply- and demand-side barriers and suggests a need to identify and address gaps between Nepal's School Health and Nutrition Programme as a policy and its implementation throughout the country. Even for known effective interventions, such as micronutrient supplements, there is a need for further research on effective implementation strategies, particularly to reach adolescent populations (23). Similarly, awareness of and use of adolescent-friendly health clinics was noticeably low among all adolescents, and indicates a need for increased investments in awareness campaigns and efforts to further strengthen service quality for this government-provided service.

WASH, especially strategies to go beyond open defecation and to focus on menstrual hygiene management, have become major priorities in South Asia, in part because menstruation can be a barrier to school

attendance, where schools lack appropriate facilities (29). In Nepal, there are strong stigmas surrounding menstruation, and for some communities, discriminatory practices due to beliefs of impurity during menstruation persist (30). Other studies in Nepal have found that socio-cultural norms require girls and women to change their routines during menstruation, but we found that nearly all adolescent girls continue to go to school, and <10% avoid certain foods during menstruation. However, ~40% do not sleep in their own bed, driven by traditional beliefs in South Asia about the impurity of menstruation (31). Only about one-third use commercial/disposable pads during menstruation, which is consistent with other South Asian study findings that the majority still use cloth and rags not designed for menstruation (32, 33). Given the sociocultural intergenerational factors at play, menstrual hygiene interventions in South Asia will likely need to reach not only adolescents but also family members, teachers, and the wider community (34).

The low level of social, health, and nutrition awareness, especially among YAGs, is of concern. Among YAGs, >8 of 10 and nearly all OAGs and AMs had heard “girls should be at least 18 years before marriage,” suggesting that messages from the National Strategy to End Child Marriage in Nepal and campaigns against early marriage, such as the Girls Not Brides initiative, have reached the population. One in 5 of the OAGs, however, were already married and their average age of marriage was ~16 y, suggesting further work is needed. It is important to remember that this decision is sometimes made by the adolescent, but sometimes by parents, grandparents, or others, and therefore broader dialogues and shifts in sociocultural norms are needed to change the average age of marriage. The reason for the consistently reported difference in the age at which boys and girls should marry is not known, although it does reflect the current average gap of women marrying 4 y earlier than men (19).

In our sample, nearly all YAGs and most OAGs, compared with almost none of the AMs, were currently in school. This is consistent with prior studies globally linking early marriage and pregnancy with school drop-out (2). Married Nepalese adolescent girls are 10 times more likely to quit school than unmarried Nepalese adolescent girls (35). These findings also suggest that in Nepal a school-based adolescent program would reach almost all YAGs, but would miss some OAGs and almost all of those who are married. A systematic review of nutrition interventions suggests schools can be an effective platform for delivering micronutrient supplementation and improving micronutrient status (36). However, programs using radio and the internet would likely reach more AMs than OAGs and less than half of YAGs. Similarly, a mobile health intervention would reach almost no YAGs, but more than half of the OAGs and almost three-quarters of the AMs. In addition to paying attention to which platform would be most helpful for ensuring intervention coverage, current exposure and knowledge levels are important to consider for shaping the content of interventions and choosing delivery platforms.

Programs targeting adolescents must recognize the heterogeneity in needs, interests, and physiological, emotional, and social maturity throughout adolescence; marital and reproductive status; school attendance; and other contextual factors. These characteristics will determine which platforms (e.g., schools, community, mass media) and topics are most appropriate. For example, in this context, schools seem to be an ideal platform for maximizing reach to YAs, whereas outreach clinics from adolescent-friendly health facilities, engaging families, and TV

and radio programming offer opportunities for complementary programming. Adolescents should be at the center of decision-making and the design of such programs, to ensure relevance, appeal, and accessibility (37). The global nutrition community should build on other sectors’ experiences (38); the sexual and reproductive health and WASH communities have engaged children and adolescents in meaningful ways, for example, through peer support and discussion groups. There could also be much to learn from multisectoral maternal and child nutrition programs.

A strength of this study is the breadth of information on adolescent nutrition, health, and WASH, including exposure to sources of information, knowledge, and practices. The study presents an emerging picture of the health and nutrition concerns of adolescents in Nepal and builds on a similar implementation science study conducted in Bangladesh (34), because this type of information is necessary to design evidence-informed programs. Future rounds of this panel will add detail to these findings and enable causal assessment of the determinants of certain practices and nutrition and health outcomes. Future research should also explore the unmet needs of adolescent boys. Additional key variables that shape the different stages of adolescence and the life trajectories of adolescents, such as migration, physical activity, urbanization, and mental health, should also be studied; and qualitative work is needed to probe social and contextual factors, including the likely important role of parents, grandparents, and peers, that shape adolescents’ food access and choices, aspirations, vulnerability to school drop-out, and early marriage and childbearing. The adolescent nutrition conceptual framework is a useful guide to such research and for testing the hypothesized pathways. Filling data gaps will help inform refinements to this framework. Finally, to truly understand adolescent nutrition and enable evidence-based interventions, researchers need to create standard, validated indicators appropriate for this population, including standardized techniques for measuring adolescent growth and validated DDS for boys and men and for girls aged <15 y, and tools for assessing less tangible but equally important determinants of well-being and nutrition such as self-efficacy, life satisfaction, and dimensions of empowerment.

Adolescence is a period of change and development with opportunity for interventions to enhance the nutritional status and well-being of this and future generations simultaneously. Policies and programs will be most effective if they concurrently address the immediate causes of malnutrition but also individual, household, and community level determinants. To date, exactly what programs should do and how remains largely unclear. Implementation science studies like this, however, can guide efforts to reach target populations, using effective channels with appropriate content for each cohort of adolescents. These data, for example, guided critical decisions for the design of SII adolescent programming, notably: 1) prioritize younger adolescent girls given the gaps identified in their knowledge and exposure to information; 2) focus on school-based interventions, given that almost all could be reached through this 1 delivery channel; 3) discontinue plans for SMS and social media designed for adolescents, given their low ownership of mobile phones; and 4) use peer models to equip adolescents with knowledge and skills to address school and community problems and improve adolescents’ self-efficacy. These evidence-informed approaches are aligned with the government of Nepal’s Adolescent Health and Nutrition Strategy. Importantly, the scale-up of implementation is being done

gradually while continuing to build on evidence of what works for the country's adolescents at different stages of adolescence.

Acknowledgments

We thank all program and collaborating organizations who have worked to design, pilot, and implement adolescent programming affiliated with Suaahara II. We specifically acknowledge New ERA, the local survey firm, responsible for collecting these data on an annual basis. All authors gratefully acknowledge USAID for their support of Suaahara II, including the prioritization of adolescence as a learning agenda.

The authors' responsibilities were as follows—KC: designed and conducted the research; DE: analyzed data; KC, AP, DE, SM, and JN: wrote the paper; KC: had primary responsibility for final content; and all authors: read and approved the final manuscript.

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