

Towards more comprehensive analyses of the Nutrition Transition among adolescents in the rural South: an empirical contribution

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Key words

Nutrition transition, adolescents, diets, physical activity, sustainability

Abstract

The processes of rural transformation, defined as socio-economic changes that affect the ways people live and organise their livelihoods in agrarian contexts, can have profound impacts on diets and physical activity patterns. Such processes can change food environments in ways that can increase availability of calorie-dense and processed foods options. At the same time the introduction of technological innovation may modify the intensity of rural livelihood activities (i.e. work, travel, and leisure). Therefore, when designing research, policies and interventions that address the challenges to achieve the production and consumption of sustainable diets, there is a need to recognise the holistic nature of shifting lifestyles and what is needed to reverse the interconnected obesity and environmental crises from a food systems perspective. This chapter showcases a novel approach that integrates data from wearable activity-trackers in a mixed-method study design to further our understanding on the interplay between changing diets and physical activity among adolescents in rural Telangana (India). We also include reflections on the ethical and practical considerations when engaging with adolescents in research. The aim of the chapter is to demonstrate the advantages of engaging with a holistic concept of *sustainable lifestyles* (comprising diets and physical activity) to address the health challenges adolescents face in rapidly transforming societies.

1. Introduction

Contextual and historically embedded rural transformation processes, that includes extensive societal and economic changes, can drive rapid dietary shifts and changes in physical activity patterns [1]. Given that imbalances between diets and physical activity are among the causes that led to the obesity epidemic [2], analytical frameworks and practices to achieve sustainable diets in transforming agrarian contexts, will benefit from incorporating in research, policy and interventions the complex linkages between what people eat and how they work, travel and spend their leisure time.

These considerations are particularly important for interventions targeting adolescents, who are, especially in the Global South, at the forefront of dramatic shifts in diets and lifestyles caused by rural transformation [3,4]. Since adolescence is a critical window of opportunity to recover from previous nutritional impairments and to enhance the health of the next generation [5], identifying what is contributing to dietary and physical activity changes is key to contain the growing rates in the prevalence of diet related non-communicable diseases [6].

This chapter describes an empirical approach that aims to contribute to the nascent research on the interplay between changing diets and physical activity among adolescents in the agrarian South, where rural transformation is taking place. Through our contribution we aim to emphasize the importance of integrating considerations on sustainable lifestyles when designing interventions and policies to achieve sustainable diets.

The focus of the chapter is on rural India, where overweight and obesity rates have increased dramatically in the last decade [7,8]. Illustrating our case study in rural Telangana (southern India), we show how to combine data derived from new technologies (i.e. accelerometer devices), quantitative surveys and qualitative interviews. Together with reflecting on ethical and practical considerations when engaging with adolescents in research, our chapter aims to contribute to: 1) the research on the health challenges adolescents face in the context of rural transformation; and 2) raise questions that can guide the design of interventions and policies that, in tandem, aim to improve diets and physical activity levels.

The chapter is organised as follows: Section 2 discusses the research gaps in adolescent nutrition addressed in this study and describes the instruments used; Section 3 showcases how integrating data from a mixed-method study can provide a more nuanced picture of adolescents activities in relation to dietary behaviours; Section 4 reflects on key ethical and practical considerations in conducting research with adolescents; Section 5 concludes.

2. Blind-spots in sustainable nutrition research with adolescents: a contribution from mixed-methods

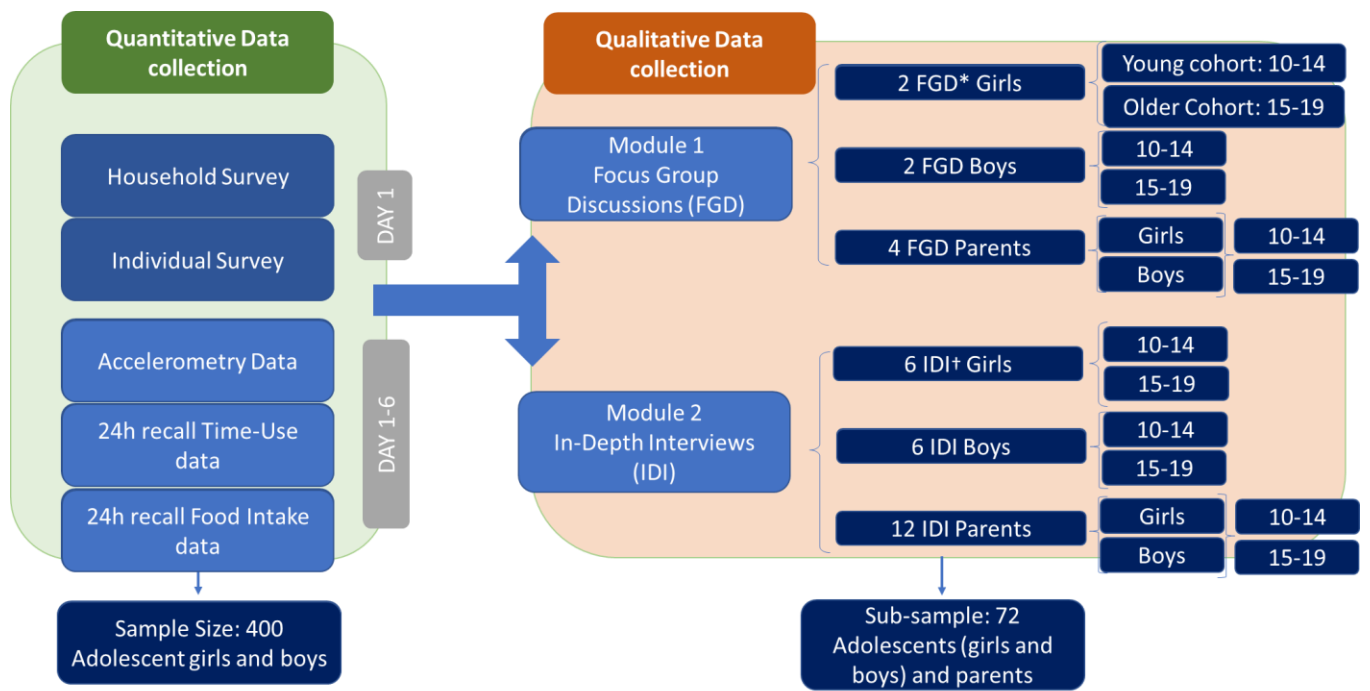
Conventionally, research on adolescent nutritional and health in the global South has focused on the analysis of anthropometric indices and dietary intake at the individual level [9,10]. Our *mixed-method sequential explanatory*¹ study design (Figure 1) addresses two broad gaps in this area of research. Firstly, there is a lack of systematic data collection that links on energy expenditure and

¹ Mixed-methods sequential explanatory study design implies collecting and analysing first quantitative and then qualitative data in two consecutive phases within one study.

physical activity patterns among teenagers in the agrarian South [11]. In turn, this limits the understanding of health risks that emerge from the interplay between variations in physical activity and dietary intake patterns among this important age group. More holistic understanding can be gained if dietary assessments go hand in hand with evaluations of physical activity patterns. To this end, 24h recall food intake data from 400 adolescent boys and girls in rural Telangana, was combined with energy expenditure data from accelerometer devices. Data were collected across six consecutive days and complemented with 24hrs recall time-use surveys during the same period. These were in turn complemented by a household and individual survey administered before the above-mentioned instruments. Combining food intake data with energy expenditure and activities, provides promising avenues to produce a comprehensive picture of the dietary and physical activity challenges that adolescents face in transitioning (rural) societies.

The second gap we aim to address relates to the missing links between individual-level dietary practices and physical activity, on the one hand, and household and community dynamics and enforced norms, on the other [10]. There is a growing recognition that researchers and public health practitioners should move beyond individual-level approaches to design and test interventions [12]. Importantly, adolescent boys and girls should be positioned within their households and communities where gender, age and carer-child relations of power shape intra-household food consumption and work allocation. To capture these dynamics, we deployed a series of focus group discussions and in-depth interviews with a sub-sample of adolescents and their parents/carers. These interviews complemented quantitative findings. Table 1 presents the selected methods and survey instruments together with some examples of insights and type of outputs they can produce.

Figure 1. Mixed-method study design



Notes: *each focus group discussion (FGD) included six members, one facilitator and one note taker. † Three In-depth Interviews (IDIs) were conducted with the younger cohort of adolescent girls and three with the older cohort. The same sex/age structure was replicated for adolescent boys and respondent's parents.

Table 1. Methods and Instruments justification: research gaps, questions and examples of the types of insights

Research gaps	Methods/Instruments' characteristics	Examples of insights and type of outputs
<p>Lack of systematic and integrated data on physical activity and dietary behaviours in the agrarian South</p>	<p>Accelerometer devices detect and record both speed and direction of movements and algorithms are used to translate data into aggregate measures of activity intensity (light, moderate, vigorous and very vigorous activity) and energy expenditure in kcal. This study employed the research-graded tri-axial ActiGraph GT3X+ accelerometers, whose validity and reliability have been extensively assessed [13,14] and used in multiple studies involving free-living humans [15,16] including adolescents [17]. Data were collected at 30Hz/second and movements were translated to energy expenditure using validated age-based cut-points [18,19]. ActiGraph GT3X produced several indicators, described in Box 1. More information on fieldwork protocol and data management can be found in Zanello et al. [20].</p>	<p>-Total Energy Expenditure* (daily)</p> <p>-% of Activity Energy Expenditure* across different types of activities</p> <p>- Physical Activity Level* (daily)</p>
	<p>24h food intake surveys provide retrospective assessments of food and beverage consumption during the preceding 24 hours [21]. Administered by trained enumerators, questions are asked in chronological order of consumption over different context specific meals. To capture habitual food consumption, multiple recalls are essential. The more days/periods of recall, the better capture of between-day and seasonal variability.</p>	<p>-Daily Kcal intake</p> <p>-% of calories by food source/group</p> <p>-Micronutrient adequacy</p>

	<p>24h recall time-use surveys capture the use of time in relation to different categories of activities (e.g. paid and unpaid work, market and non-market activities, education, leisure and personal time) [22]. Time-use interviews have previously been used with adolescents [23] and provide a daily snapshot of the activities conducted during the day before the interview. We used a 30-minute activity interval and a piloted context-specific pre-defined list of activities and allowed respondents to include missing options.</p>	<p>% of time spent on different types of activities (classified in macro and micro-groups)</p>
<p>Missing links between individual-level behaviours (dietary practices, physical activity) and broader household and community norms/values.</p>	<p>FGDs are a particular form of group interview intended to exploit group dynamics which is conducive to gather information of socially accepted knowledge and beliefs [24,25]. FGDs strength resides in the outcomes of collective interaction, namely how ideas publicly manifest themselves in a given context [24]. As interaction among participants is a central aspect of focus groups, the selection of participants needs to be carefully considered to mitigate power imbalances. With this intention, we interviewed groups of adolescents and their parents/carers divided by gender and age and avoided mixing groups.</p> <p>IDIs provide the opportunity to deepen the generation of understanding [26]. The rationale to use IDIs and complement surveys and FGDs include: 1) to explore conforming patterns and characteristics; and 2) investigate peculiarity and differences among interviewees to document between and within-group heterogeneity. In addition to gender and age group, sampling criteria included household socio-economic status</p>	<p>-Picture of how family context influences teens' diets and physical activities</p> <p>-Identification of gender and age norms that shape behaviours;</p> <p>- Map parent-teen interactions that define dietary choices/ physical activity opportunities.</p>

	(based on wealth index) and not attending school or being married and/or being a parent among older adolescents.	
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**Full definition of the terminology is provided in Box 1.*

Box 1. Indicators produced using Actigraph accelerometer devices: useful definitions.

ACTIVITY ENERGY EXPENDITURE (AEE): calories used to perform different forms of physical activities. AEE is directly generated by accelerometer devices and is a function of the intensity of activities and of body weight. AEE represents approximately 30% of TEE.

BASAL METABOLIC RATE (BMR): number of calories required to support basal physical functions (fuel the brain, heart, lungs, kidneys, etc). BMR is a function of age, sex, body size and body composition and represents approximately 60% of TEE. BMR estimation requires the use of a formula like the Harris-Benedict [27].

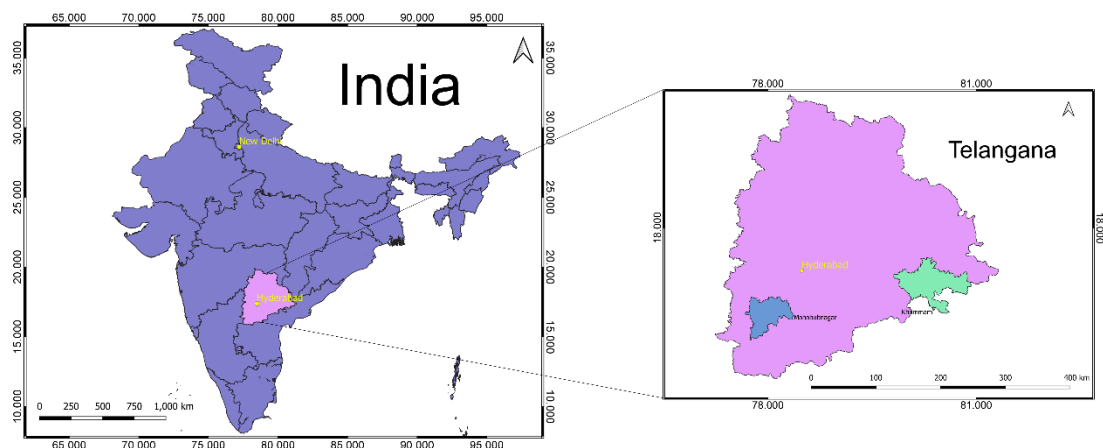
TOTAL ENERGY EXPENDITURE (TEE): sum of BMR, AEE and of the Thermic Effect of Food (TEF – or the energy needed to digest and metabolise food).

PHYSICAL ACTIVITY LEVEL (PAL): ratio of TEE to BMR and a measurement of the intensity of physical activity corrected for age, sex and body size. This feature makes PAL a suitable index to compare the intensity of work across populations.

3. India case study: Settings and Data

The study was conducted between 2019-2020 in Khammam and Mahabubnagar districts, located in the central and south agro-climatic zone of Telangana.

Figure 2. Study sites: the state of Telangana and the districts of Mahabubnagar and Khammam.



3.1 Quantitative data

3.1.1 Sample description

The quantitative sample included 400 adolescents (11-19 years old) from 347 households. Table 2 reports household and individual characteristics. Physical activity parameters i.e., AEE, TEE, and PAL are significantly higher for boys compared to girls. For instance, TEE for boys exceeds that of girls by 11% in the younger cohort and 25% in the older cohort. PAL is similar across age

groups and gender. In terms of energy intake, boys exceed girls by 9% and 15% for younger and older cohorts, respectively.

Table 2: Descriptive statistics of households and individual respondents by age group, and sex.

	Early Adolescent (10-14 yrs)			Late Adolescent (15-19 yrs)		
	Boys	Girls	t-test	Boys	Girls	t-test
Household characteristics						
Head of the household age (years)	44.7	43.4	1.3	45.1	46.9	-1.8
Head of the household education (years)	5.9	6.5	-0.5	6.7	6.4	0.3
Household size (number of HH)	4.7	4.5	0.2	4.2	4.4	-0.1
Wealth Index (based on assets ownership)	0.2	-0.1	0.3	0.2	-0.1	0.3
Individual characteristics						
Height (in cm)	145.9	146.1	-0.2	164.4	153.8	10.6***
Weight (in kg)	33.5	34.8	-1.3	49.2	43.8	5.4***
BMI Status (WHO- 1SD)						
<i>Underweight</i>	0.71	0.57	0.14*	0.64	0.52	0.12
<i>Normal</i>	0.24	0.40	-0.16*	0.31	0.46	-0.15*
<i>Overweight</i>	0.04	0.03	0.01	0.05	0.02	0.03
Daily energy consumption and intake						
Basal Metabolic Rate (BMR)	1180.4	1095.9	84.5***	1493.1	1198.5	294.6***
Activity Energy Expenditure (AEE)	475.0	392.8	82.2***	430.9	346.3	84.5***
Total Energy Expenditure (TEE)	1655.4	1488.7	166.6***	1924.0	1544.9	379.1***
Physical Activity Level (PAL)	1.41	1.36	0.05***	1.29	1.29	0.00
Energy intake (kcal)	1596.6	1462.6	133.9***	1705.8	1486.2	219.6***
Percent of energy intake from processed foods ¹	0.4	0.4	-0.0*	0.4	0.4	-0.01
Compliance of accelerometer wear						
Avg. number of days per participant†	4.7	4.8	-0.1*	4.6	4.7	-0.1
Total number of days‡	177.9	196.4	-18.5***	228.9	227.2	1.7
Observations (participant/day)	421	461		472	454	

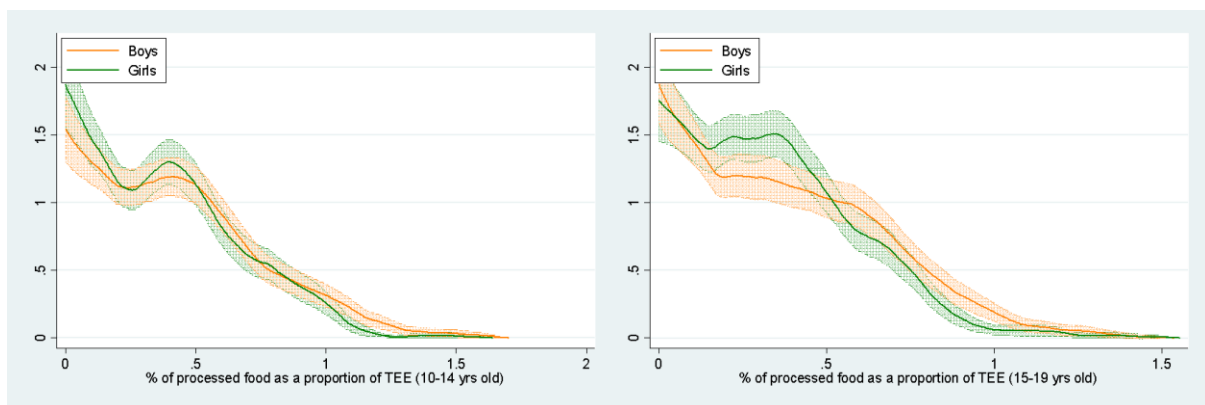
Notes: †Average number of days with valid data (non-wearing time less than 3 h throughout the day) out of the five days of the survey. ‡Total number of distinct day-level observations (individuals × valid days surveyed). Asterisks show level of significance ***= significant at 0.1% level, **=significant at 1% level and *=significant at 5% level. ¹

The selection of processed foods was based on Monteiro et al. 2010. The ration include consumption of both processed and ultra-processed foods [28].

3.1.2 Combining food intake and physical activity data: two examples.

Figure 3 plots the distributions of the contribution of calories from processed foods as a proportion of TEE, by sex and age groups. As rural transformation is taking place in many rural areas, diets and patterns of physical activities change. Convenient but unhealthy processed foods can become widely available and livelihoods that were physically demanding shift to more sedentary lifestyles. The graphs show the proportion of energy requirements met by calories from processed foods. For ratios $>$ ($<$) 1 energy intake from processed foods exceeds (is lower than) TEE. The distributions reveal significant differences within and between sex and age groups. The processed food to TEE ratio among younger cohort girls is relatively smaller in comparison with the same cohort boys. On the other hand, older boys tend to have a greater intake of processed foods in relation to their energy expenditure, i.e., the ratio is >1 . The relatively small ratio of processed foods derived calories to TEE ratio that is >1 , is not surprising given our context of analysis. However, we should also question whether: any amount of processed foods consumption among adolescents is acceptable at all? Are some types of processed foods qualitatively less (more) harmful than others? Do higher levels of processed food intakes influence the intensity of activity patterns (i.e. PAL)? Are these patterns somehow linked with new findings that illustrate how increased ultra-processed food consumption is associated with increased appetite [29]?

Figure 3: Distribution of processed foods derived calories intakes to Total Energy Expenditure ratio, by sex and age groups.

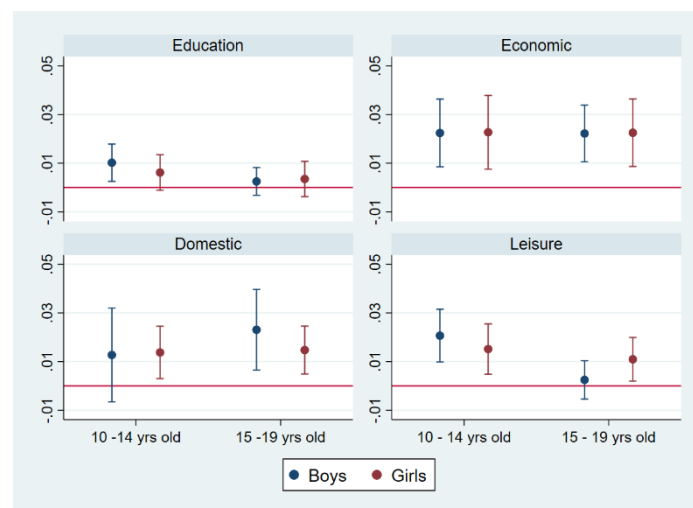


Note: Notes: 95% confidence intervals computed over 1,000 bootstrapped repetitions. Two-sample Kolmogorov-Smirnov test for equality of distribution: Younger cohort ($p=0.198$) and older cohort ($p=0.014$).

Figure 4 reports the contribution (i.e. coefficients) of time spent across four main activities (i.e. education, economic, domestic, leisure) on PAL, by sex and age groups. The data and analysis

shows the marginal effects on PAL of a one-unit increase in the explanatory variables. For example, one-unit change of economic and domestic activities tend to have the largest marginal effects on PAL in both age cohorts of boys and girls. In the case of leisure and education, the marginal effect on PAL is higher in the younger cohort than the older cohorts. A unit-increase of leisure activities of boys has a larger marginal effect on PAL compared to girls. The data raises questions of the duration and nature of economic and domestic activities, how they change in relation to age and gender, and whether they represent an opportunity cost in relation to exercise and “formative” occupations. In terms of policies and interventions, these considerations can help address the relatively lower energy intensity of leisure activities of older cohort girls, by introducing appropriate and desirable activities to promote healthy lifestyle.

Figure 4: Contribution of activities on PAL, by sex and age groups.



Note: Graph plots coefficients from a regression model of PAL on a set of activities (education, economic, domestic, and leisure). Sleeping and resting as baseline. The model controls for day of the week and missing hours. Standard errors clustered at individual level. Full regressions of determinants of Physical Activity Level (PAL) are presented in Table A at the end of the chapter.

3.2 Qualitative Themes ²

FGDs and IDIs transcripts were read and analysed by a researcher familiar with the context of Telangana. A combined deductive and inductive approach was employed for theme identification and analysis. The deductive approach was based on pre-identified themes focusing on the research questions, while the inductive approach was undertaken for emerging themes from the transcripts. Once all data was coded, two researchers revisited and revised categories,

² Information about the sample of the qualitative module is provided in Figure 1.

that were in turn discussed and developed into main themes. Below we report a sample of themes, with some direct quotes from participants. Coding was conducted on Nvivo12. These themes enhance the evidence provided by quantitative data illustrated above. They integrate the knowledge and experiences of adolescents and their families in negotiating boundaries and opportunities in rapidly shifting societies.

Nutrition Knowledge

Younger and older adolescents demonstrate good nutrition knowledge and a detailed understanding of how nutrition influences health outcomes. This information is mainly obtained from their families, school, media and friends. Children listed a comprehensive range of vitamin-rich foods and distinguished them from foods that provide energy and strength. This knowledge was reinforced by interviews conducted with parents.

“At home, mother, father and elders say if you drink milk, you will have more strength, and if you eat eggs, you will get energy” (Young adolescent girl FGD).

“At school, our physics madam (teacher), through experiments she showed us as well – in what foods, what nutrition is there” (Young adolescent girl FGD).

While food consumption at home tends to be more supervised, eating out during recreational activities may be unmonitored. The options were regarded generally as “less healthy” and sometimes unsafe, but also more enticing and tastier. As the ability to gather outdoors is more accepted among boys, this group tended to report higher levels of processed foods consumption outside than girls.

“Outside food is good due to its colour and taste” (Young adolescent boy, FGD).

“Do not eat outside food – mother says. Asks me to eat good foods – potato, ladies finger, bitter gourd, all these, she asks me to eat” (Young adolescent boy, FGD)

Gendered food allocation

Virtually all parents recognised that girls and boys should have the same diets. However, in practice diets were different between them and across age groups: leafy vegetables were prioritised for girls while animal protein was generally allocated to boys. Some of the main reasons reported included lesser body absorption of animal protein by girls, while boys needed protein and more calorific

foods because they were more active. Reproductive health considerations for girls were also reported. These beliefs were reiterated by adolescents themselves.

“If it’s girls, for them chicken, mutton, the energy to assimilate it is not sufficient. If it’s boys, as they can assimilate it, that is why they mostly eat non-veg, and so girls generally eat pulses, vegetables, leafy vegetables, eggs, to remain active. (FGD, Parent of young adolescent boy).

As [girls] grow older, non-veg [options] should be reduced, and as the age comes, even if you eat it, [they] will not digest.” (IDI, Parent of older adolescent girl).³

Changing food environments

During the IDIs, parents were also asked to reflect on their diets during adolescence and compare them to that of their children. Adults talked about food shortage, both in terms of variety and quantity, and often cited that skipping meals was common during their childhood. Most of the focus was given on the availability and affordability of increased varieties of vegetables, fruits, animal source proteins and sweet options. However, interviews also highlighted a sense that some types of foods were no longer available.

“Before, one meal would be there, another would not be there, it used to be like that – and [we went] to school like that only. Now there is no such deficit, how much ever hard it might be, for food there is not struggle.” (IDI, Parent of older adolescent boy).

Now compared [to before], there is a lot more food. We’re eating much more, sweetly, nicely” (IDIs, Parent of older adolescent boy).

Opportunities and challenges to physical activity

Physical activity and mobility opportunities were heavily influenced by gender. Boys were more likely to participate in outdoor events and economic work. Girls’ physical activity, on the other hand, was primarily domestic and agricultural work on family land.

“My experience is that, as girls keep doing the cooking work – while we boys have food and go and roam around here and there. Boys have more freedom. But for girls, they will not have that freedom.” (FGD, Older adolescent boy).

³ Wording included in the squared brackets are added by the authors to provide more context.

Parents fears for their daughters' safety and norms around good behaviour were among factors for restricting their outdoor physical activity opportunities. Parents would also articulate that lack of courage of girls would justify limited mobility. These narratives could often collide with adolescent's own voices, and girls would share a sense of uneven treatment compared to boys.

"In our villages, if it is boys, they go around here and there. Now if the girls are going and coming, then they say "see how she is roaming around". Like that we shouldn't get a bad name, we should tell our girls to be disciplined, and keep them at home. If it is boys [...]there is no fear for him" (IDI, Parent of older adolescent girl).

"Now, if it will be the boys means, at whatever time they may go, they say – he is a boy, wherever, whenever, anywhere he can go and come, they say like that." (IDI, Older adolescent girl).

4. Lessons from conducting research with adolescents

The mixed-method study presented in this chapter is an adaptation of a methodology developed to study the rural livelihoods-nutrition-energy expenditure nexus among farmers in the global South [30,31]. Hence, various steps were taken to adapt the approach with adolescents in rural Telangana. Ethical and safeguarding protocols were developed following Santelli et al. [32] and Brandy and Graham [33] guidelines to conduct health and social research with children and young people . Conducting research with adolescent respondents represents a valuable opportunity in agri-health research as it enables to incorporate the experiences of a demographic group that was previously overlooked. These sections present few core ethical and practical considerations applied during the preparation and execution of this study.

4.1 Ethical Considerations

When conducting research with children and young people **no harm and providing benefits** is the key principle that shapes the study's lifecycle. The principle refers to the balance between the inclusion of children and young people's views and experiences while considering common risks of partaking to research activities (e.g. opportunity costs, psychological and emotional distress) [33]. Inherent and unexpected risks should be anticipated, assessed and mitigated and distressing topics avoided or carefully planned. As well and benefitting society at large or improving policies, it is worth exploring what benefits participants may enjoy in return for providing time and data for research. Considering appropriate thank you gifts⁴ and planning enjoyable activities while providing learning opportunities from research outputs, could be considered.

Informed consent addresses the questions of ensuring that young respondents fully appreciate the consequences of the research while assessing their ability to provide consent. The following principles should be integrated into the design, planning and acquisition of informed consent [32,33]:

- *Working with gatekeepers* (people with parental responsibilities and/or work with minors) is common when conducting research with the under-age population. Their priority is to protect individuals under their responsibility and can have a better grasp of the commitment that the research would entail.
- *Autonomy* refers to the person's ability and rights to make their own decisions. Therefore, even if gatekeepers provide consent, the child's individual autonomy should remain intact and repeatedly checked. It is therefore important to use validated protocols to gain multiple level informed consents. Figure 5 illustrates the protocol used in this research. Treating consent as a live and ongoing dynamic is critical. For young respondents refusing consent may be expressed indirectly and/or non-verbally.
- *Capacity, age, cognitive ability* will determine whether a child or young adult is able to provide valid consent. To this end, technical jargon should be avoided, while information and consent processes should be accessible and age-appropriate.
- *Opt-out options* should be available and repeatedly reminded. This is valid also when data collection is terminated within a pre-defined timeframe.

Researchers need to anticipate and explore potential **confidentiality issues** and protect them together with **anonymity and privacy**. This refers to respondents as well as others impacted transversally by research activities. Confidentiality procedures should be explained at the beginning of each session, especially when running group discussions. Finally **balancing safeguarding concerns with confidentiality** means that the welfare and safety of young respondents involved in the study override research interests. It is therefore best practice to anticipate and plan for safeguarding policies and providing training on how to use it to all involved in fieldwork.⁵

⁵ Institutions working with under-age individuals will normally have pre-existing safeguarding procedures. Alternatively, the NSPCC provides guidance on writing adequate safeguarding policies (<https://learning.nspcc.org.uk/safeguarding-child-protection/writing-a-safeguarding-policy-statement>). This research was reviewed and approved by the Ethics Committee at the University of Reading and by the National Institute of Rural Development (India).

5. Conclusions

The cycle of sedentarization and nutrition transition unfolding in the global South among adolescents is a complex and multifaceted process. The dominant narrative on rural areas is one that depicts daily and constant physical exertion in “traditional” livelihood activities and consumption of traditional diets. While these considerations are partly true, the transition of rural lifestyles and diets is ongoing in growing economies.

To help design and implement timely and comprehensive policies that address overweight and obesity among adolescents in rural contexts, conceptualizations, and practices on how to achieve sustainable diets will benefit from integrating considerations on sustainable lifestyles. Firstly, the concept of the sustainable diets in rural areas should be linked with: 1) the availability and access to nutritious foods; 2) environmentally sustainable food systems; 3) physically sustainable agricultural production in the absence of mechanization (for example, farmers will still require energy-dense foods if agricultural work continues to be physically demanding). Secondly, in the context of rapid societal transformation, the problem of diets can be compounded by a decline in physical activity. Debates and interventions on how to render food systems more respectful of consumers, safe for workers and enhancing for ecosystems should go hand in hand with promoting inclusive built environments that encourage outdoors activities and safe access to recreational facilities for girls and boys of all ages.

We hope this chapter contributes to the conversation on extending the use of mixed-methods to holistically assess the quantity and quality of diets and physical activity when designing research and interventions to achieve production and consumption of sustainable diets. Structural transformations intersect with: i) social networks, parental guidance, school-based practices; and ii) historical and socio-economic factors, gender and age norms. In turn, these factors shape the interplay between food consumption and physical activity behaviours in youths. To understand these connections, context-specific and mixed-methods insights on food intakes and physical activity are central to inform the development of comprehensive and tailored interventions to address structural and environmental issues, as well as influences within households, schools and communities.

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Appendix

Table A: Full regressions of determinants of Physical Activity Level (PAL).

	Younger adolescents (11-14 years old)		Older adolescents (15-19 years old)	
	Males	Females	Males	Females
Education activities	0.010*** (0.004)	0.006* (0.004)	0.003 (0.003)	0.003 (0.004)
Economic activities	0.022*** (0.007)	0.023*** (0.008)	0.022*** (0.006)	0.023*** (0.007)
Domestic activities	0.013 (0.010)	0.014** (0.005)	0.023*** (0.008)	0.015*** (0.005)
Leisure activities	0.021*** (0.005)	0.015*** (0.005)	0.002 (0.004)	0.011** (0.005)
Non wearing time	-0.001*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)	-0.000*** (0.000)
Constant	1.288*** (0.044)	1.283*** (0.041)	1.255*** (0.031)	1.222*** (0.034)
Wald chi2	10.765***	18.905***	10.798***	9.793***
R-squared	0.171	0.170	0.217	0.159
Sample size	421	461	472	454

Notes: Regressions estimated at day/level. Sleeping and resting activities as baselines. Robust standard errors (in brackets) are clustered at individual level. ***Denotes statistical significance at the 1% level, ** at 5% level and * at 10% level.