



SUSHAMA AVINASH KHOPKAR

Health Profile of Adolescents
Living in Slums in Nashik City, India

A cross-sectional study



ACADEMIC DISSERTATION

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Summary

Adolescents, young people of 10-19 years of age, constitute 21% of the total population in India. Adolescents of urban slums suffer from adverse living conditions such as unsafe water, poor housing, overcrowding, and limited health facilities, especially when compared to school-going urban adolescents not living in slums. These underprivileged and often understudied young people were the focus of the research here.

This was a descriptive cross-sectional study of the health and well-being of the adolescents living in two randomly selected slums of Nashik City in the state of Maharashtra in Western-central India, and was conducted during 2010-2011. The detailed data on household characteristics, parents, adolescent lifestyle and health were collected through household interviews and measurements, from 276 households and 545 adolescents. The study combined information from five topics, *viz.*, nutrition and growth, mental well-being, blood pressure and lifestyle, reproductive health, socio-demographic variables, and attempted to achieve/answer the following main research questions and aims :

1. How is the growth, as measured by the anthropometric measurements of height and weight of the study subjects and how does it compare to the general Indian and WHO standards? How do the socio-demographic factors such as parental education, income, and diet associate with these measures?
2. What is the prevalence of hypertension in the study population and what roles do stress and mental health play on blood pressure? The secondary aim was to check the association of anthropometric measurements and lifestyle factors on mental health.
3. At what age do the girls living in slums attain menarche and is this age associated with the nutritional status and different types of oils and fat in the diet?
4. What is the prevalence of reproductive tract infections, observed using the self-reported symptoms suggestive of reproductive tract infections, and how does it associate with the mental health?

The growth was assessed by stunting and nutrition status. The stunting was measured using the height-for-age score and the nutritional status using the body mass index-for-age score. The diet data considered were related to food items rich in protein, energy and fat. Mother's education, household per capita income and the size of household were the main socioeconomic variables used in the analysis. A mental well-being score was developed and

used in various analyses. The different types of fat, vegetable oil, ghee (clarified butter), meat/fish/eggs and dairy products, were segregated for the analysis. The data were summarised using descriptive statistics and graphical tools, and were analysed using logistic and multivariate linear regression models, taking into account household effects. The latter was necessary because some adolescents might be from the same household. The key study findings were the following:

1. Stunting was more prevalent than thinness in the study subjects, and more common among boys (ranges of stunting 13%-41%, thinness 0%-18%, and overweight 0%-8%) than girls (ranges of stunting 4%-31%, thinness 4%-19%, and overweight 0%-10%). Mother's higher education significantly lowered the prevalence of stunting among boys and girls and thinness in girls. In addition, having more than five household members reduced stunting, and increasing household income reduced thinness among girls. However, consumption of protein- and energy-rich food did not show any significant association.
2. The overall prevalence of prehypertension among the study subjects was 20%. Both systolic and diastolic blood pressure were significantly higher among those with worse mental status. Both types of blood pressure were significantly lower among stunted and thin adolescents while higher among overweight adolescents. The diastolic blood pressure was higher among girls and it also increased with father's education among the adolescents. It was also observed that adolescents with worse mental status were more stunted and reported having general health-related problems.
3. The average age at menarche was 13.7 years. Height was positively associated with the consumption of ghee, and the consumption of vegetable oil was negatively associated with the age at menarche. However, consumption of dairy products, meat, fish and eggs were not associated with the age at menarche.
4. The results indicated that the symptoms suggestive of reproductive tract infection were reported by almost half of the post-menarcheal girls. Having these symptoms and low height (stunted) both negatively associated with the mental well-being.

This study has brought out the important areas of health of adolescents living in challenging slum conditions. The research also calls for larger studies focusing on the role of mental status and blood pressure, knowledge, attitude and practice of sexual and reproductive health, and dietary habits so that proper interventions can be planned to bring about behavioural changes in these vulnerable people. The girls and women of India have gathered increasing

attention in recent years, however boys and men may also be in a precarious position. This study has brought out that the health and well-being of both boys and girls need to be investigated. The mother's role is crucial in children's growth and educating mother about children's needs might have long-term positive effect. However, the father's role, even though not very prominent on the surface in Indian culture, in caring for children and their well-being should not be neglected.

Tiivistelmä

Nuoruus on siirtymävaihe lapsuuden ja aikuisuuden välillä jota leimaa kasvun nopeutuminen. Nuoret ovat yhteiskunnan rakennuspalikoita ja näin ollen terve nuorisoväestö on osa valtion vaurautta. Suuri osa Itä- ja Kaakkois-Aasian nuorista kärsii kroonisesta aliravitsemuksesta ja anemiasta mikä haittaa heidän kehitystään. Ravitsemuksellisia puutostiloja, riippuvuuksia tupakkaan ja alkoholiin sekä muuta päihteidenkäyttöä, mielenterveyden häiriöitä, suojaamatonta seksuaalikäyttäytymistä ja sukuelininfektioita tavataan nuorten keskuudessa. Useamman kuin yhden tällaisen ongelman samanaikainen esiintyminen yksilöllä tekee hänet alttiiksi vakaville terveysongelmille. 10–19-vuotiaat muodostavat 21 % Intian väestöstä. Urbanien slummien nuoret kärsivät haitallisista elinolosuhteista, epäpuhtaasta juomavedestä, heikoista asuintiloista, liikakansoituksesta ja rajallisista terveyspalveluista verrattuna koulua käyviin urbaaneihin nuoriin, jotka eivät asu slummeissa. Tutkimuksia Intian urbanien alueiden ja maaseudun nuorten terveysongelmista on julkaistu aiemmin, mutta vähemmän tutkimustietoa on tarjolla urbanien slummien nuorista. Näiden huono-osaisten nuorten pituuskasvuun, verenpaineeseen, mielenterveyteen ja seksuaaliterveyteen liittyviin yleisiin terveysongelmiin tarttuminen voisi olla merkittävä askel katkaistaessa sukupolvienvälistä noidankehää, johon kuuluu aliravitsemusta, kroonisia sairauksia ja köyhyyttä.

Tämä tutkimus suoritettiin poikkileikkaavana havainnointitutkimuksena kahdessa satunnaisesti valitussa slummissa Nashikin kaupungissa, intialaisessa Maharashtran osavaltiossa, marraskuun 2010 ja huhtikuun 2011 välisenä aikana. Päättävöitteena oli selvittää urbaaneissa slummeissa elävien nuorten terveydentilaa suhteessa tutkittavien ravitsemuksen tilaan, verenpaineeseen, ruokatottumuksiin, mielenterveyteen, seksuaaliterveyteen ja elintapaan. Tätä tarkoitusta varten rekrytoitiin 545 iältään 10–19-vuotiasta. Aineisto kerättiin haastattelemalla osallistujat käyttäen strukturoituja kyselyitä ja tekemällä heille antropometrisiä mittauksia ja verenpainemittauksia. Kyselyt kattoivat taustatiedot, elintapamuuttajat, fyysisen aktiivisuuden, yleisterveyden ja ruokavalion. Tämä väitös tarttuu neljään spesifiseen nuorten terveyteen liittyvään aihealueeseen: antropometriseen profiiliin, jolla tutkitaan kasvua; verenpaineprofiiliin ja mielenterveyteen; kuukautisten alkamisikään ja ruokavalioon; sekä mielenterveyteen ja sukuelininfektioiden oireisiin.

Ensimmäisen osatyön tarkoituksena oli kuvata nuorten antropometrisiä piirteitä ja ravitsemuksen tilaa ja tutkia siihen liittyviä muuttujia. Pituus suhteessa ikään ja painoindeksi (engl. body mass index) suhteessa ikään toimivat kitukasvuisuuden (engl. stunting) ja laihuuden mittareina arvioitaessa niiden yleisyyttä osallistujien keskuudessa. Samalla kitukasvuisuuden ja laihuuden yleisyyttä verrattiin WHO:n ja Intian vertailuväestöihin. Kitukasvuisuus oli laihuutta yleisempää tutkimukseen osallistuneilla ja pojat kärsivät siitä tyttöjä enemmän. Iän vaikutus kitukasvuisuuteen oli pojilla erilainen kuin tytöillä. Äidin koulutustason ja ruokakunnan koon suhdetta sekä kitukasvuisuuteen että laihuuteen tutkittiin. Äidin koulutustaso korreloi erittäin merkittävästi sekä kitukasvuisuuden että laihuuden kanssa tytöillä ja pojilla. Ruokakunnan koko ja tulot korreloivat merkittävästi tyttöjen ravitsemustilanteen kanssa. Äitien kouluttaminen nuorten ravitsemuksellisiin tarpeisiin liittyen voisi parantaa nuorten antropometristä profiilia ja tulevaa terveyttä.

Verenpaineprofiileja ja korkean verenpaineen yleisyyttä 10–18-vuotiailla tytöillä ja pojilla arvioitiin toisessa osatyössä. Kehitimme mielenterveysasteikon ja verenpaineen yhteyttä tämän asteikon lukemiin tutkittiin huomioiden tunnetut riskitekijät kuten ikä, pituus, painoindeksi ja suvussa esiintynyt korkea verenpaine. Systolisen verenpaineen kanssa merkittävästi korreloivat muuttujat olivat ikä, keskitason lukema mielenterveysasteikolla, kitukasvuisuus ja laihuus. Lisäksi diastolisen verenpaineen kannalta merkittäviä olivat sukupuoli, korkea lukema mielenterveysasteikolla ja isän koulutustaso. Siirryttäessä alhaisista mielenterveysasteikon lukemista keskitasolle, verenpainelukemat alenivat ja sama tulos havaittiin asteikon korkeilla lukemilla. Tulokset osoittivat, että nuorten riski huumaussaineiden väärinkäyttöön, terveysongelmiin ja kohonneeseen verenpaineeseen oli korkeampi, mikäli heillä havaittiin merkkejä ahdistuksesta. Siksi huomiota tulisi kiinnittää nuorten mielenterveysohjauksen tärkeyteen.

Kolmannessa osatyössä arvioitiin kuukautisten alkamisiän sekä rasvoja ja eläinproteiinia sisältävien ruokien kuluttamisen ja antropometrisen statuksen yhteyttä tytöillä, joilla kuukautiset olivat alkaneet. Kuukautisten alkamisikä (keskiarvo 13.7 vuotta) tutkimuksen slummeissa oli suhteellisen korkea verrattuna Intian keskiarvoihin. Kuukautisten alkamisikä ei korreloinut maitotuotteiden, lihan, kalan tai kananmunien kuluttamisen kanssa. Ruokakunnan henkeä kohti kuluttamalla kasvivasvan määrällä oli käänteinen yhteys tytön kuukautisten alkamisikään ja tulokset viittasivat positiiviseen korrelaatioon kirkastetun voinin (ghee) käytön

ja kuukautisten alkamisiän välillä. Nämä yhteydet eivät hävinneet, kun huomioitiin antropometrinen status ja sosioekonomiset piirteet. Rasvojen ja proteiinia sisältävien ruokien kulutus huono-osaisissa talouksissa Intiassa on alhaista ja heijastuu verrattain myöhäiseen kuukautisten alkamisikään.

Toisessa osatyössä kehitettyyn mielenterveysasteikkoon palattiin neljännessä osatyössä, jossa tarkasteltiin asteikon lukemien yhteyttä tyttöjen seksuaaliterveyteen. Erityisesti tarkasteltiin yhteyttä itse ilmoitettujen sukuelinten tulehdusoireiden ja mielenterveyden välillä. Lähes joka toinen tyttö, jolla kuukautiset olivat alkaneet, ilmoitti sukuelinten tulehduksiin viittaavia oireita tutkimusta edeltäneen vuoden ajalta. Heikompaan mielenterveyteen merkittävästi liittyvät muuttajat olivat kitukasvuisuus ja sukuelinten tulehduksiin viittaavat oireet. Slummioloissa työillä, joilla kuukautiset olivat alkaneet, mielenterveys ja jotkin somaattisen terveyden piirteet näyttävät olevan vahvasti yhteydessä toisiinsa.

List of original publications

This dissertation rests on the four original articles listed below and referred to in the text by Study I-IV. Articles can be found at the end of this thesis. In addition, some unpublished data is presented.

- I. Sushama A. Khopkar, Suvi M. Virtanen, Sangita Kulathinal (2014). Anthropometric characteristics of underprivileged adolescents: A study from urban slums of India. **Journal of Anthropology**, Article ID 197048, 9 pages; DOI: [http:// dx.doi.org /10.1155/ 2014/197048](http://dx.doi.org/10.1155/2014/197048).
- II. Sushama A. Khopkar, Suvi M. Virtanen and Sangita Kulathinal (2015). Mental health, anthropometry and blood pressure among adolescents living in slums of Nashik, India. **Tanzania Journal of Health Research** 17(4), 9 pages;
Doi: <http://dx.doi.org/10.4314/thrb.v17i4.6>.
- III. Sushama Khopkar, Sangita Kulathinal, Suvi Virtanen and Minna Säävälä (2015). Age at menarche and diet among adolescents in slums of Nashik, India. **Int J Adolesc Med Health**, 6 pages; DOI 10.1515/ijamh-2014-0056.
- IV. Sushama Khopkar, Sangita Kulathinal, Suvi M. Virtanen & Minna Säävälä (2016). Mental wellbeing and self-reported symptoms of reproductive tract infections among postmenarcheal adolescent girls: Findings from a cross-sectional study in an Indian slum (submitted for publication in Finnish year book of population).
- V. Sushama A. Khopkar, Suvi M. Virtanen, and Sangita Kulathinal (2017). Corrigendum to Anthropometric Characteristics of Underprivileged Adolescents: A Study from Urban Slums of India ; **Journal of Anthropology**, vol. 2017, pp. 1–2.

Abbreviations

BDI	Beck's depression inventory
BMI	Body mass index
CVD	Cardio vascular disease
DBP	Diastolic blood pressure
GHQ	General health questionnaire
HIV	Human immunodeficiency virus
IIPS	International Institute for Population Sciences, in Mumbai, India
RTI	Reproductive tract infection
SBP	Systolic blood pressure
SD	Standard Deviation
UNICEF	United Nations International Children's Education Fund
WHO	World Health Organisation.

1. Introduction

Adolescents, young people of 10-19 years of age, are central to realising development that is sustainable and equitable, and they are the future of the society. Adolescents who are healthy and happy are better equipped to contribute to the society as young citizens. They will also be strong building blocks for their society when they enter into adulthood and transit to parenthood. The adolescent population is considered as a country's wealth, since many developed countries are facing severe problems brought on by an ageing population and scarcity in labour force. There were 1.6 billion persons aged 12-24 in the world in 2012 (Patton 2007).

Adolescence is the period of transition between childhood and adulthood, and it is one of the most rapid phases of human development. This phase of life brings in biological maturity, beginning with physical changes of puberty, followed by psychological maturity, learning to manage emotions and relationships. Hence, this is a period of life with specific health and developmental needs, and a time to develop knowledge and skills. Although the developmental process and the changes appear to be universal, the timing and the speed of change vary among individuals. These changes are influenced by both individual and environmental characteristics, such as sex, nutrition, habits, hygiene, behaviour, sanitation, and overall living conditions. The changes in adolescence have health consequences over the life-course, and hence, investing in adolescent education, health and the work force can shape the well-being of tomorrow's adults and the coming generations. Despite the recognised importance and need to address the health issues of adolescents, the research in the field of adolescent health is scarcely adequate. Many young people bear the burden of poor health owing to economic hardship and unfavourable living conditions such as those existing in urban slums.

India has a large population of adolescents constituting almost 243 million (Census of India 2011). About 15% of the total urban population of India lives in slums (Census of India 2011, Upinder 2013). Maharashtra has the highest slum population as a proportion of the urban population (27.3%) in India (Upinder 2013). Generally, the slum population is economically poor and also hierarchically positioned low in a caste society. Assessment of health issues of the adolescents in slums, needs special consideration, since this subpopulation constitutes a large proportion of the urban population and suffers from adverse living conditions such as unsafe water, poor housing, overcrowding and limited health facilities, especially when

compared to school-going urban adolescents not living in slums.

This thesis on the health profile of adolescents from urban slums is neither a complete epidemiological report on the disease burden among adolescents, nor a public health policy or programme guide. Instead, it addresses a range of issues of interest to picture young people's health situation in order to make it, once again, explicit that specific attention in health policy and programmes are required for adolescents. Such groups of adolescents are in need of youth-friendly health services, which will help them achieve and sustain healthy behaviour. The elements of this picture, each to be examined in a separate chapter, include anthropometric profile, mental wellbeing, blood pressure profile and reproductive health.

2. Literature review

2.1 General health of adolescents in low-income countries

The literature on adolescent health and related issues is vast, especially from developed countries. Hence, the review here is restricted to Asia and India, in particular, in most parts. The main topics for the literature search were anthropometry, blood pressure, mental well-being and issues related to the reproductive health of adolescents. A recent report, on adolescent health published by the WHO gives a comprehensive account of this research area and the research needs (WHO 2012). According to the WHO, in 2012 approximately 1.3 million adolescents died who could have been saved, if they had been treated in time. Further, 330 adolescents per day died due to road traffic injuries. Other main causes of adolescent deaths included HIV, suicide, lower respiratory infections and interpersonal violence. Of all mental health disorders in adults, 50% appear to have started by the age of 14 years, but in most cases, they remain undetected and untreated (WHO 2012).

India is recognised worldwide for the large size of its adolescent population. Major health problems observed in adolescents in the country are undernutrition, nutrient deficiencies, obesity and, anorexia nervosa, emotional problems, behavioral problems, identity problems, sexually transmitted infections, substance abuse and injuries (IIPS 2006: Results from the National Family Health Survey-3). In India, every year on an average, 26% of girls marry below the age of 15 years and 54% of girls below the age of 18 years. Of the adolescents, 4.5% are drug abusers. Of all HIV positive new infections, 50% are in the age group of 10-25 years. At least 20% of young people (10 to 24 years) in India are likely to experience some form of mental illness, such as depression, mood disturbances, substance abuse, suicidal behaviours, eating disorders and others (WHO 2012, Singh et al. 2014).

Millions of children live in urban slums in India, without access to basic services. They are vulnerable to dangers from living in crowded settlements. Their situations and needs are often represented by aggregate estimates that show urban children to be better off than their rural counterparts, obscuring the disparities that exist among the children within the cities. This has resulted in behavioural problems in children living in urban slums (Kalaiyarasan et al. 2014). The data available on physical growth, nutritional and health status demonstrate that the health scenario of a large proportion of adolescents in India is plagued by undernutrition, anaemia and

infectious diseases resulting from poor environmental sanitation and ignorance about cleanliness.

2.2 Nutrition and growth

Nutrition is an input to and foundation for health and development. Interaction between infections and malnutrition is well documented. Better nutrition means a stronger immune system, less illness and better health. Malnutrition is a major contributor to the total global disease burden, and poverty is a central cause of it (WHO 2005). Further, the socioeconomic status of a family affects the nutritional status (Harishankar et al. 2004), especially in girls (UNICEF 2009). Children of poor socioeconomic status have moderate, severe, acute or chronic malnourishment (Elankumaran 2003, IIPS 2007), and over half of the children from this group are undernourished in India (Ramachandran 2003, IIPS 2007). Some adolescents are particularly vulnerable to poor health and adverse developmental outcomes as a result of individual and environmental factors, including marginalisation, exploitation and living without parental support.

Childhood undernutrition remains a major health problem in India, especially in slums (Ghosh et al. 2004, Kapur et al. 2005, Bisai et al. 2009). A high prevalence of underweight, stunting and wasting was observed among the slum children (Bisai et al. 2009). Anthropometric measures help in assessing nutritional status and health risks among adolescents (WHO Tech. Rep. 854 1995, Thakor et al. 2000). The three most common anthropometric measures are height, weight and body mass index (BMI).

Recommended measures for assessing nutritional status in school-aged children and adolescents are height-for-age and BMI-for-age (de Onis et al. 2007). Low height-for-age is classified as stunting and low BMI-for-age as thinness and high BMI-for-age as overweight and obesity (de Onis et al. 2007). Stunting is a primary manifestation of malnutrition in early childhood and is an indicator of chronic undernutrition, while thinness indicates current malnutrition. Stunting increases the risk of morbidity, impairs cognitive development, and reduces work productivity in later life (Basu et al. 2014). The consequences of undernutrition extend not only to later life, but also to future generations (WHO Fact sheet 2005). Both childhood obesity and thinness are linked to under achievement in school and lower self-esteem (Kramer 1987). Assessment of stunting and thinness is crucial for adolescents, and a reference population is central to it.

Studies from India have used height-for-age and BMI-for-age z-scores, which are derived using WHO as well as Indian reference populations (Khadilkar et al. 2011, Rawat et al. 2014). Household characteristics such as the mother's education, poverty, and household size are closely linked to aggregate anthropometric failure in India (Arnold et al. 2005, Gaiha et al. 2014). It is known that the mother's education is generally reflected in a child's wellbeing and health. Educated mothers could be more aware of health issues, with more means to get information than uneducated mothers (Arnold et al. 2005). Dietary fat protein are important macronutrients for the growth of children (Mary et al. 2005). In many studies on anthropometric profile, dependence on dietary fat protein was examined.

2.3 Mental wellbeing

Mental wellbeing is a dynamic state in which the individual is able to develop potential, work productively and creatively, build strong and positive relationships with others and contribute to their community. It is enhanced when an individual is able to fulfil his/her personal and social goals and achieve a sense of purpose in a society (Jenkins 2008).

A set of questions used in this study, to study the mental wellbeing of adolescents, was derived using the General health questionnaire.-12 and Beck Depression Inventory (BDI) II due to the wide age range (10-19 years) of the study participants. Hence, we review the literature on GHQ-12 and BDI II .

The GHQ is a measure of current mental health and since its development by Goldberg in the 1970s it has been extensively used in different settings and different cultures (Goldberg et al. 1970, Goldberg et al. 1988, Jacob et al. 1997, Schmitz et al. 1999, Donath et al. 2001). The questionnaire was originally developed as a 60-item instrument, but at present a range of shortened versions of the questionnaire including the GHQ-30, the GHQ-28, the GHQ-20, and the GHQ-12 are available. The scale asks whether the respondent has experienced a particular symptom or behaviour recently. Each item is rated on a four-point scale (less than usual, no more than usual, rather more than usual, or much more than usual); and for example, when using the GHQ-12 it gives a total score of 36 or 12 based on the selected scoring methods. The most common scoring methods are bi-modal (0-0-1-1) and Likert scoring styles (0-1-2-3). Since the GHQ-12 is a brief, simple and easy to complete, its application in research settings as a screening tool is well documented.

The WHO study of psychological disorders in general health care in 15 different centres indicated that substantial factor variation between centres exist for the GHQ-12. Similar studies among young adolescents reported that the GHQ-12 is a particularly useful measure with adolescents where there are likely to be a number of different threats to their psychological health, such as poor self-esteem, that may not necessarily constitute a formal psychiatric condition (Tait et al. 2003). In India, the GHQ-12 has been validated against the Indian Psychiatric Survey Schedule and has been found to demonstrate excellent sensitivity and specificity, meaning that it is able to accurately identify the presence of psychological disturbance with few false negatives and false positives (Shamsunder et al. 1986). A study of life events, life strains and coping behaviours were compared in psychologically 'distressed' and 'non-distressed' college students. Of the total, 21% fell in the distressed group. Students who obtained a high score on the GHQ experienced a significantly greater number of negative life events and strains and more subjective distress compared to 'non-distressed' (Zeena et al. 1990).

The Beck Depression Inventory (BDI) was created in 1961 by Aaron T. Beck, with the purpose of determining the severity and intensity level of the symptoms of depression (Farinde 2013). The Beck Depression Inventory is a widely utilised 21-item self-report scale in both clinical and research studies (Beck et al. 1996). The scale was originally developed in 1961 as an interviewer-assisted format. The Beck Depression Inventory-II is a depression rating scale that can be used in individuals that are ages 13 years and older, and it rates symptoms of depression in terms of severity on a scale from 0 to 3 based on the 21 specific items.

Gender is among the most commonly observed variables associated with mental wellbeing (Torsheim et al. 2006, Patel et al. 2007, Landstedt et al. 2009). Several studies have shown that the quality of relationships within family (mainly siblings and parents) is a major determining factor of psychological wellbeing in adolescents. The other factors contributing to fluctuations in psychological wellbeing in adolescents are stress (Siddique et al. 1984), physical health (Mechanic et al. 1987) and both popularity and intimacy in peer relationships.

Epidemiological studies of adolescent mental health in the slums are few (Fatori et al. 2013). Factors associated with mental health disorders or symptoms in slum conditions are low educational status, unemployment, and large family size (Silvanus et al. 2012) ; male gender, lower socioeconomic status, large family, being first born, having low birth weight, and a BMI

less than 18.5 (Rahi et al. 2005). Family violence and restrictions to independence were associated with mental health problems (Ram et al. 2014). Physical punishment and maternal anxiety/depression are among other important factors associated with mental health in slum conditions (Fatori et al. 2013).

2.4 Blood pressure

High blood pressure or hypertension is an important public health burden in all populations of the world. Recent ‘Global Burden of Hypertension’ data showed that more than a quarter of the world’s adult population (nearly one billion) had hypertension in the year 2000, and this is projected to increase by about 60% (to 1.56 billion) in 2025 (Kearney et al. 2005). Hypertension is one of the leading causes of cardiovascular disease (CVD) and premature mortality and the lifetime risk of developing hypertension exceeds 50% for most populations (Murray et al. 2013). The World Health Report 2002 estimates that 7 million premature deaths were attributable to hypertension.

Hypertension is showing an increasing trend in developing countries like India. In India, the prevalence of hypertension has increased by 30 times in urban populations over 25 years, and by 10 times in rural populations over 36 years (Padmavati 2002).

In children, blood pressure tracking patterns in the United States have confirmed that persistent blood pressure elevation may be related to hypertension in adulthood (Bao et al. 1994), and that there appears to be ethnic variations in blood pressure trajectories (Manatunga et al. 1993). The emerging evidence also suggests that primary hypertension is detectable and occurs commonly in the young (Pediatrics 2004). In addition, the presence of elevated blood pressure in childhood has been linked with left ventricular hypertrophy (Daniels et al. 1998).

Hypertension has its origin in childhood. It is very essential to detect it during this period so that hypertension complications can be prevented at an early stage (Sukumar et al. 1978, Agrawal et al. 1982, Agrawal et al. 1992). Although blood pressure normally increases with growth and development; children with higher levels of blood pressure tend to either maintain that position as they mature or progress to higher levels of blood pressure in adulthood in comparison to their peer group (Lupekar et al. 1999). In addition, the presence of elevated blood pressure in childhood has been linked with left ventricular hypertrophy (Daniels et al. 1998). Data from diverse populations show that the tracking of blood pressure from childhood

into adulthood is very strong (Voors et al. 1977, Durrani 2011). A cohort of 756 subjects (with baseline information as a cross-sectional study in 2002) was followed up in 2006 to track BP distribution in adolescents (Soudarssanane et al. 2008).

The risk factors influencing blood pressure can be categorised into non-modifiable and modifiable factors. The non-modifiable factors include ethnicity, genetic influences, age, gender, seasonal variation, and the modifiable factors include food habits, physical activity, smoking, tobacco use and alcohol intake. Some other factors that influence blood pressure are : height, weight, overweight, somatic growth and sexual maturation, sodium, type of dietary fat and other dietary intakes, sympathetic nervous system reactivity and stress.

The data on blood pressure profile in Indian school children are inadequate with few studies showing different patterns of normal blood pressure (Agrawal 1983, Sachdev 1984, Gupta et al. 1990). Taking into account the above observations and findings and the early detection of hypertension in children and adolescents seems to be the best strategy for the prevention of hypertension in adulthood.

2.5 Reproductive health

Adolescence is one of the most rapid phases of human development. Biological and psychosocial maturity takes place during this period, culminating in sexual maturity. The onset of menstruation, menarche, is a major indicator of growth and maturation for girls. The timing and speed with which the changes take place are influenced by both individual or internal and environmental or external factors. Certain health problems seen in adolescence may reflect both the biological changes of puberty and the societies and cultures in which they are growing up.

In most of India, students currently are not provided structured, comprehensive sexual health or sexuality education in secondary schools (Sengupta 2009). In 2009, in a courageous attempt to adjust educational policy in India, the Ministry of Human Resources Development proposed the Adolescence Education Program, a comprehensive sex education program that would be implemented into school curricula across the country. A parliamentary committee rejected the proposal, citing that the ‘social and cultural ethos are such that sex education has absolutely no place in India’ (Sengupta 2009).

Age of menarche in urban India was shown to be 12.6 years, and in rural India it was in the range of 15-16 years (Das et al. 1966, Rana et al. 1986, Singh 1992, Agrawal et al. 1992, Sen 1994, Indian Pediatrics 2006).

The variation in mean age at menarche is associated with heredity, family size, dietary habits, nutritional, birth order, general health consideration, some chronic diseases and different environmental factors like effects of climate, altitude, rural and urban residence and the socio-economic level of family (Tanner 1962).

In addition to the most important genetic determinants of age at menarche, the single environmental factor that stands out possibly explaining as much as 25% of the individual deviation in the age of puberty- is nutritional status in childhood (Karlberg 2002). The most widely studied dietary factor in relation to age at menarche is energy intake. In a review article, age at menarche in developing societies is concluded to reflect a trend in energy balance rather than in general nutritional status. The protein source of the diet in early life could also influence the timing of puberty, because high animal against vegetable protein ratio at ages 3-5 years is associated with earlier puberty even after controlling for body size. The sum effect of phyto-estrogens in the diet may be anti-estrogenic. A phyto-estrogens rich diet has been suspected to delay puberty (Khadilkar 2006).

There are several misconceptions and traditional beliefs regarding menstruation and practices during menstruation are mostly unsafe and unhygienic (Gupta et al. 1998). The physiological process of menstruation is still regarded as an unclean state, such perceptions segregate girls from the activities of normal life, such as bathing, swimming and exercise (Rierdan et al. 1995), which may make girls vulnerable to depression and stress as well as reproductive problems. About 40% - 45% adolescent girls reported menstrual problems. The reason for this might mainly be psychosocial stress and emotional changes (Chakravarty 1989). Menarche emerged as a strong predictor of depression and anxiety among adolescent girls. Even after the addition of measures of perceived social stress to a multivariate model, the association of depression and anxiety with menarche persisted (Patton et al. 1996).

The understanding of reproductive health in general and young adult reproductive health is considered to be poor in India, and most needs to solve these problems are not adequately addressed (Jejeebhoy 1998). The resistance to sex education in schools, combined with a

formative phase of adolescence and young adulthood, can leave young people unprepared for the realities of being an adult, specifically with regard to sexual behaviour. Reproductive tract infections (RTIs) are one of the important sexual and reproductive health problems among adolescents, irrespective of their sexual activity. Some RTIs are sexually transmitted, but environmental conditions, poor general health status and poor personal hygiene can also contribute to RTIs. (Whittakar 2002). The common reproductive health problems among young girls in India are menstrual problems, reproductive tract infections and gynaecological problems and they are reported as principal health concerns by adolescent slum-dwelling girls in India. (Joseph et al. 1997, Mmari 2014).

The prevalence of self-reported RTI symptoms among Indian women of age group 15-24 years has been 11–18% in nationally representative studies. The prevalence of laboratory-diagnosed RTI symptoms has ranged from 28% to 38% for Indian women in the age group of 15-24 years. According to studies that have explored women's patterns of seeking treatment for RTI symptoms, between one-third and two-thirds of symptomatic women did not seek treatment (Sabarwal et al. 2012). A positive association between age of women and RTIs was also observed, and women having no child have recorded the highest prevalence rate, around 40% both in urban and rural areas (Kanitkar et al. 2004).

The reproductive mental health situation of unmarried women and adolescents in low-income settings, such as urban informal settlements in India, remains particularly poorly understood (Astbury 2009, WHO 2009). With this motivation, we addressed rather open research questions of association between age at menarche and diet and mental wellbeing and self-reported symptoms of RTIs among post-menarcheal girls.

2.6 Justification of research

Adolescents constitute a large part of the population of India, and nearly 10% - 30% of young people suffer from adverse health impacting behaviours and conditions. According to a UN report, an estimated 1.7 million young people aged 10 to 19 years die each year in India due to accidents, violence, and problems related to pregnancy or illnesses that are either preventable or treatable. Many adolescents develop chronic illnesses that affect their quality of life. Anaemia is very prominently observed among the population in the age group of 10-19 years. Malnutrition in children and adolescents is at a high level, and it can cause lifelong health

problems, while failure to care for pregnant adolescents can damage their own health and that of their offspring.

When there is a shortage of food, it is not well understood that adolescents require extra nutrition for their growth and development. Inadequate diet and poor nutrition can delay development; in girls, it can delay puberty and can lead to the development of a small pelvis. Poorly nourished adolescent mothers are more likely to give birth to babies with a low birth-weight and the health problems pass from one generation to the next. Earlier studies have reported unprotected and unsafe sexual behaviour among adolescents, resulting in unwanted pregnancies, unsafe abortions and the steep rise in the prevalence of the HIV infection. A large number of adolescents living in slums do not attend school, work in vulnerable situations, and are likely to get exposed to tobacco and alcohol (Ashoka 2014). The challenging environment and living conditions of urban slums may have adverse effect on their mental wellbeing.

The majority of the studies involving adolescents from India have been undertaken in schools, where adolescents from socially and economically higher classes attend. The published studies have mostly focused on one or a few aspects, e.g. anthropometric measurements or hypertension or menarche or mental wellbeing or reproductive health or growth status. The literature lacks studies addressing various aspects of the health of adolescents simultaneously.

As described above, there is enough evidence indicating the unmet need for assessing health status and factors affecting it, of adolescents from the underprivileged sector of the society. A more complete picture of the anthropometric, blood pressure, mental wellbeing and reproductive health profile of adolescents from urban slums would be useful to address the major problems and plan interventions for the improvement of their general health.

3. Aims and objectives of the study

Regular assessment of growth is important for monitoring health during childhood and adolescence. Screening for adolescents to identify those who are not consistent with normal growth in a population is an essential step prior to clinical investigation (Bong et al. 2012).

The purpose of this thesis was to gain insight into some of the key areas of health of adolescents from slums in India and to understand factors affecting their health. The specific objectives of the study relate to nutrition and growth, mental wellbeing, blood pressure and lifestyle, and reproductive health. Main research questions and aims are as follows.

The specific objectives of the study relate to nutrition and growth, mental wellbeing, blood pressure and lifestyle, and reproductive health. Main research questions and aims are as follows :

1. How is the growth, as measured by the anthropometric measurements of height and weight, of the study subjects and how does it compare to the general Indian and WHO standards ? How do the socio-demographic factors such as parental education, income, and diet associate with these measures ?
2. What is the prevalence of hypertension in the study population and what roles do stress and mental health play on blood pressure ? The secondary aim was to assess the role of anthropometric measurements and lifestyle factors on mental health.
3. At what age do the girls living in slums attain menarche and is this age associated with the nutritional status and different types of oils and fat in the diet ?
4. What is the prevalence of reproductive tract infections, observed using the self-reported symptoms suggestive of reproductive tract infections, and how does it associate with the mental health ?

4. Subjects and methods

4.1 Subjects and overview of the study cohorts and design

The study area was the slums of Nashik city. Nashik is located in Western India, in the state of Maharashtra. Nashik is a fast-growing industrial city. It is the third largest city in Maharashtra after Mumbai and Pune and the 14th most populous city in India. According to the Census of India, in 2011, Nashik city had a population of nearly 1.5 million, males constituting 54% of the population and females 46%. Nashik had an average literacy rate of 74%, higher than the national average of 64%, male literacy was 80%, and female literacy was 66%. About 14% of population is under 6 years of age, and 53% between 15–59 years of age. Hinduism, Islam, Buddhism and Jainism are the major religions in Nashik with 64%, 23%, 10% and 2%, respectively of the population following them. About 13% of the city population resides in the slums (Census of India 2011) with a sex ratio (females per 1000 males) of 924 and literacy rate 71%. The Nashik non-slum population has a sex ratio of 848 and literacy rate of 91%. Though the literacy rate is high in the non-slum population, the sex ratio is very low as compared to the slum population. This is alarming in view of social development.

The sampling used in this study is explained in Figure 1. Nashik has 59 notified slums, 32 within the city limits and 27 on the outskirts of the city. Two slums (one within the city limits and one on the outskirts) were randomly selected. The two slums selected were Sundarnagar and Phulenagar.

Sundarnagar slum is on the outskirts of Nashik city. There are seven small streets in this slum. Cement roads are built up in between the households. It is situated on a small stream known as Valmiki river. There are 298 households in the slum. Nearly 2000 people live in this slum. One full street has a Muslim population. The remaining six streets have a Hindu population. All houses are of one room with an attached kitchen and washroom, but no toilet.

Phulenagar slum is one of the oldest slums within the city limits with a population of 15000. The streets of Phulenagar are densely populated and not clean. There are 20 streets, and the accompanying area is also included in it. The slum was named after Mahatma Phule, an eminent social reformer in Maharashtra, India.

Due to the lack of enumerated data on households from the selected slums, data were collected to create a sampling frame using a structured questionnaire.

Figure 1 : Selection of households from the two slums of Nashik city, Maharashtra, India

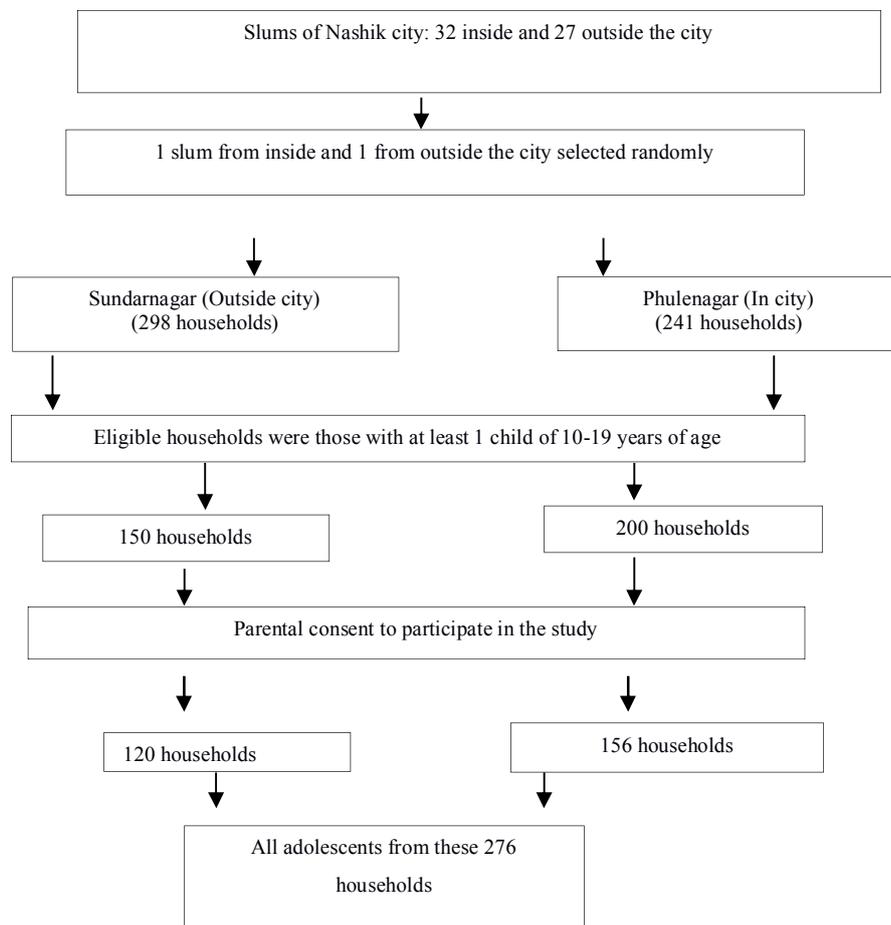
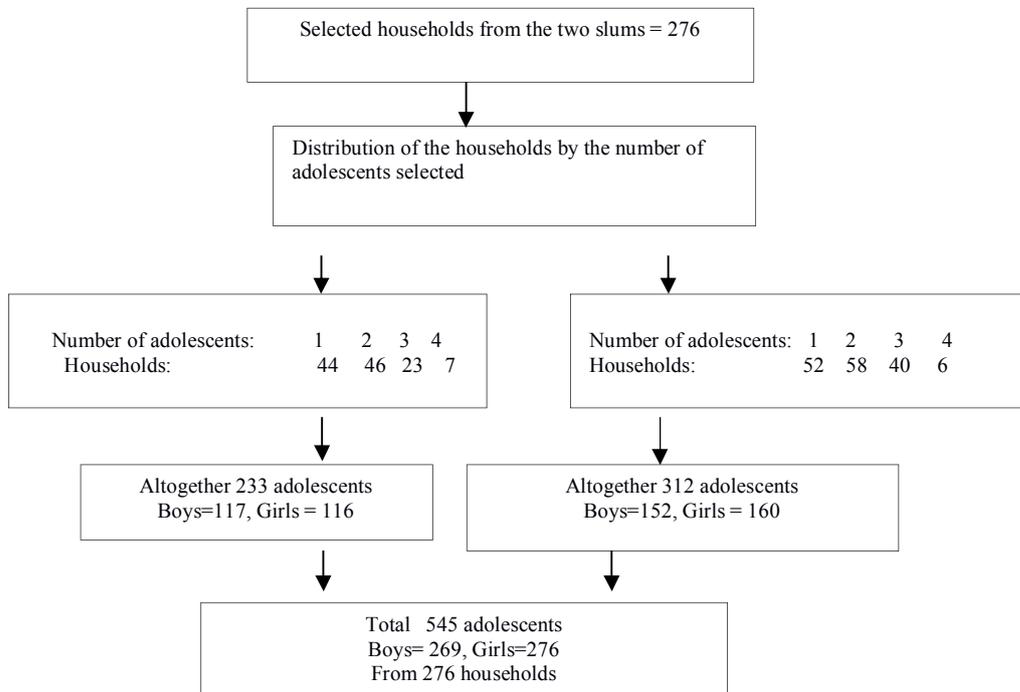


Figure 2 : The number of adolescents selected from the households of the two slums, Nashik city, India



Sampling frame questionnaire: After the selection of the slums, enumeration of the population of the two slums was undertaken using a pretested structured sampling frame questionnaire.

A survey was carried out using a sampling frame questionnaire during March 2010 and April 2010, to gather demographic data *viz.*, the number of members staying in each household, number of boys and girls between the age of 10-19 years and whether the family possessed a yellow-coloured ration-card. The yellow coloured ration-card is an indicator of the household being below the poverty line declared by the government of India, and hence, specifying a low income of the household owner.

Out of the total study population, two thirds of the population was below the poverty line of the Indian Planning Commission for the State of Maharashtra 2009-10 (below per capita monthly income of Indian Rupee 961 or US\$ 15). Using these sampling frame data, the households with at least one adolescent in the age range of 10 to 19 years were identified. Meetings with the parents of the adolescents were conducted in these slums to explain the purpose of the survey, and to obtain the written consent letters for participation in the survey. The enumeration continued until the target sample size of 500 adolescents was achieved. Every day after 4 p.m., the investigator (Mrs. Khopkar) visited the slums and checked the collected information.

Figure 1 includes the necessary detailed information of the sample. There were 298 households in Sundarnagar slum, which is on the outskirts of the city. Sampling frame questionnaires were completed by all the 298 households. There were 150 households with at least one adolescent. Out of the 150 households, written consent letters from 120 parents for the participation of adolescent/s in the survey were received. From these 120 households of the Sundarnagar slum, 233 adolescents participated in the survey. Out of the total of 233 adolescents, 117 boys and 116 girls are included in the study.

Phulenagar slum, which was within the city limits, had 1384 households. From 241 households surveyed by the sampling frame questionnaire, 200 households had at least one adolescent. Out of the 200 households, the parents' written consent letters for participation of adolescent/s in the survey were received from 156 households. From these 156 households of Phulenagar slum, the parents of 312 adolescents gave written consent letters for their participation in the survey, of which 152 are boys and 160 are girls.

Finally, the sample size for the study was 545 adolescents from 276 households.

The adolescents, whose parents gave written consent for participating in the study and who were willing to participate, included in the study. Participation in this survey was voluntary. Adolescents were guaranteed that this survey was anonymous and confidential, and answers of individuals would not be identifiable from the results.

4.2 Ethical approval

The field study was approved by the Institutional Review Board of Tampere School of Health Sciences in 2010. Ethical guidelines in the Helsinki Declaration of 1975, as revised in 2000 were followed for the conduction of this study.

Approval from the adolescents and their parents was needed for anthropometric measurements, blood pressure measurements and answering the questionnaires, which was taken in the form of written consent in the inclusion criterion of the survey.

4.3 Methods

The specific areas related to the health of adolescents: anthropometric profile for studying growth, blood pressure profile and mental wellbeing, menarche and diet, and mental wellbeing and symptoms of reproductive tract infections were selected for the studies. Table 1 and Figure 2 give a detailed picture of the various methods and sample sizes of various studies.

Table 1: Aims, methods and sample size of the studies I to IV

Studies	I	II	III	IV
Aim	Anthropometric Profile, association with socio-demographic variables and diet	Association between blood pressure, and mental wellbeing and anthropometry	Association between age at menarche and diet pattern	Mental wellbeing stunting, BMI and self-reported symptoms of reproductive tract infections
Study population	Boys and girls aged 10-18* years	Boys and girls aged 10-17** years	Postmenarcheal girls aged 10-19 years	Postmenarcheal girls aged 10-18 ***years from Phulenagar slum
Method	Anthropometric measurements Interview administered, structured, Questionnaires	Anthropometric measurements BP measurements Interview administered, structured, Questionnaires	Questionnaires Interview administered, structured,	Anthropometric measurements Interview administered, structured, Questionnaires
Sample size	518 Boys=257, Girls=261	497 Boys=250, Girls=247	160 All girls	91 All girls

*In study I, the growth curves from India are available up to the age of 18 years.

** In study II, blood pressure percentiles were available for the age 10-17 years

***In study IV, post-menarche girls from the inner-city slum were included to control the effect of the living environment and the potentially different exposure to reproductive health experience and information.

To cover various aspects of the study including sensitive issues such as addiction, having a boy/girlfriend, sexual health, following methods were used for data collection.

- Interviews of the study subjects and their parent (in most cases mothers) using structured questionnaires translated into the local language, Marathi, performed by trained surveyors,

- All the participants were able to read and write.
- The questionnaires were filled out by the surveyors, after asking each question of the questionnaires to the adolescents.
- Two teams consisting of three trained surveyors were working on this project until all questionnaires were filled out.
- Daily at 4 p.m. investigator visited the slums to check the entered data in the questionnaire. If the information was not filled out properly, it was rectified on the same day.
- Anthropometric measurements by trained technicians,
- Blood pressure measurements by experienced and trained technicians.

4.3.1 Interview-administered questionnaires

Household questionnaire : The household information of the selected households was collected using structured questionnaires by a house-to-house survey using a pre-tested questionnaire. Preferably, the mother of the selected adolescent was interviewed to collect the information for this questionnaire. The reason for interviewing the mother for this survey was that she was usually the one who was responsible for the household matters. If the mother was not available at the time of the survey, then any other senior member of the household who could provide the required information was interviewed.

The household questionnaire included questions on family and households of the adolescents. Data were collected on the following factors:

(i) number of members in the family in which adolescent stays, (ii) native state, religion, mother tongue, caste of the family, (iii) sex, age, education, literacy, marital status, work type, and income of each household member, (iv) household characteristics like type of house, number of rooms in the house, status of hygiene in the house, health of the household members, (v) whether the adolescent's mother and father had high blood pressure, (vi) information about per capita weekly consumption of oil, dal/pulses, and meat/egg/ fish were asked from the adult respondent (in most cases the mother). The question asked was how often various items were consumed weekly in the household and the quantity of each item bought per week.

Adolescent questionnaire: Once the data on households were collected, adolescents were interviewed using a pre-tested questionnaire during November 2010 and April 2011. The interviewer filled in the prescribed questionnaire by interviewing the adolescent in the presence of his/her own mother or any other senior household member, if preferred, by the respondent. The interviewer encouraged the respondent to answer the questions on topics such as addiction, sexual health without the presence of others.

The adolescent questionnaire included structured questions on:

(i) Sex, age, ability to read and write, present educational level, whether currently employed, educational level of the parents, marital status, (ii) Substance abuse and addiction, (iii) Personal health and hygiene such as pain and discomfort, sleep and energy, worry, depression, (iv) Mental wellbeing such as mood, feelings and friendship, pessimism, past failure, worthlessness, self-dislike, loss of interest, indecisiveness, self-image, changes in sleeping pattern, tiredness or fatigue, (v) Physical activities, (vi) Sexual health and behaviour, and (vii) Future perspectives.

The girl respondents were asked about age at menarche and presence of symptoms related to RTI.

4.3.2 Anthropometric measurements, blood pressure and mental wellbeing score

Camps were conducted on consecutive days, to perform anthropometric and blood pressure measurements. The participants were invited to the camps at scheduled times with their parent or guardian for the recording of anthropometric and blood pressure measurements. There were five qualified technicians (employed as nurses in clinics. on each day for taking measurements in the camp, two for anthropometric measurements and three for taking the blood pressure measurements.

Anthropometric measurements : Height (in cm) was measured using a simple non-elastic measurement tape to the nearest integer. Weight (in kg) was recorded using a new bathroom scale (Libra brand with 770 model no.) to the nearest integer. Two readings each were taken for height and weight and the average was used for analyses here.

After taking anthropometric measurements of each adolescent in person, the qualified technicians were able to recognize an adolescent with a suspected addiction, and the technicians talked to the adolescent about his/her addiction assuring confidentiality. Questions included in the adolescent questionnaire on addiction were asked again. This was the way to conduct an in-depth interview for addiction, and data collected through the questionnaires for addiction were validated.

Blood pressure measurements took place in a quiet room and special care was taken to ensure that the subject was calm and a parent or a guardian was present during the blood pressure measurements. Subjects were advised to avoid stimulating beverages like tea or coffee and to be in the supine position for 10 minutes before the measurements of blood pressure. At a gap of 5 minutes, two measurements were taken with the subject in a supine position with both arms stretched comfortably and naturally using a new aneroid sphygmomanometer with a certified accuracy of ± 2 mm Hg. The cuff size used was appropriate to the child's right arm according to recommendations by the National High Blood Pressure Education Working Group on High Blood Pressure in Children and Adolescents (2004). The average of two systolic blood pressure (SBP) and two diastolic blood pressure (DBP) measurements were used for the analysis.

Blood pressure measurements were taken by trained first aid personnel who had been actively in their job for at least 3 years.

An in-depth interview about the history of high blood pressure in one or both of the parents was conducted when the adolescent under study was accompanied by either the mother or the father. The questions included in the household questionnaire related to blood pressure were asked. The data on high blood pressure in either parent collected through the household questionnaire were validated.

Mental wellbeing was calculated by the help of twelve questions related to mental wellbeing and included the topics of being worried, feeling helpless, level of pessimism, perceiving personal failure, feeling of worthlessness, disappointment, loss of interest in other people, ability to make decisions, satisfaction with one's appearance, sleeping pattern, feeling fatigue and appetite. Thus, the questions concentrated on symptoms related to potential depression and anxiety, self-esteem, stress, and coping. Each item response was evaluated by a 4-point scoring

system ranging from a better than normal option, the same as usual and a worse than usual to a much worse than usual option. The responses were coded into two categories : 1 (better than normal option) and 0 (other options), and then all twelve answers added up to derive a total score. The total score ranged from 0 to 12; the higher the score, the better the adolescent's mental wellbeing. There is no threshold available for such binary scoring, we classified each subject, using the tertile, into one of the three categories : (i) low : score less than or equal to 7, (ii) mid score between 8 and 10 and (iii) high : score 11 or 12. Similar binary scoring has been used in other studies (Ram et al. 2014).

4.3.3 Derived variables used in the statistical analyses

Derived variables: Apart from the data collected using structured questionnaires and measurements, several variables were derived for specific analysis, and they are described below :

- **Height-for-age :** a measure of long-term nutritional status. The height of a child under study is compared with the expected height of a healthy child of the same age. The score was derived using the WHO as well as the Indian reference population (Khadilkar 2009, de Onis 2007).
- **Stunting :** a subject was classified as stunted if the height-for-age z score was below -2 SD, and not stunted otherwise.
- **BMI :** an anthropometric index of weight and height that is defined as the ratio of the body weight (in kg) to the squared height (in m). BMI is the commonly accepted index for classifying adiposity in adults and it is recommended for use in children and adolescents.
- **Thinness :** A subject was classified as thin if BMI-for-age score was below -2 SD and overweight if BMI-for-age score was above 1 SD, and normal otherwise.
- **Measures of physical health :** Stunting was defined using the Indian reference population (Khopkar et al. 2014). Prehypertension was defined using the blood pressure percentiles for given sex, age (between 10 and 17 years) and height as described in (Pediatrics 2004). For 18-year-old subjects, the standard definition of hypertension for adults was used.
- **Prehypertensive:** Blood pressure percentiles for the given sex, age (between 10 and 17 years) and height were computed using the National High Blood Pressure Education Program,

- Working Group on High Blood Pressure in Children and Adolescents 2004. If a subject had both systolic as well as diastolic blood pressure percentiles for sex, age and height below 90 then he/she was classified as normotensive. If either of the blood pressure percentiles were above 95 then he/she was classified as hypertensive, and in other cases prehypertensive. A subject with an SBP of 120 mm Hg or above, or with a DBP 80 mm Hg or above was classified as prehypertensive, even if the percentiles were below 90. For 18-year- old subjects, the standard definition of hypertension for adults was used. A subject was classified as prehypertensive with if the SBP was at least 120 mm Hg but below 140 mm Hg or the DBP was at least 80 mm Hg but below 90 mm Hg, and hypertensive if the SBP was 140 mm Hg or above, or the DBP was 90 mm Hg or above. All the others were classified as normotensive. In this thesis, prehypertensive and hypertensive are combined and are referred to as prehypertensive.
- Family history of hypertension :** The survey questionnaire included two questions on the family history of high blood pressure. If either of the parents was known to have high blood pressure, then the family history of high blood pressure was coded as yes and otherwise coded as no.
- Per capita income :** The level of economic wellbeing is one of the basic factors of the household that is reflected in child undernutrition. The socio-economic status is among the most evident variables reflected in health, also in mental wellbeing (Bosch 2005). The poverty that children experience is associated with inadequate food and low maternal education. (Bradley et al. 2002, Paxson et al. 2005, Deaton et al. 2009). The socio-economic gradient was determined by maternal- and paternal education and per capita household income; educated parents with better income can provide good facilities to their children. The Indian state-specific poverty line was used as a cutting point (Govt. of India, press note 2012).

The per capita income was obtained by dividing the total household income by the number of household members.

- Parental educational level :** The questionnaire included questions: “What is your mother’s educational level ?” and “What is your father’s educational level ?” These were used to obtain the parents’ educational levels. The mother's education level and father’s education level in this study were grouped into two categories for analysis : i) primary or no education, and ii) secondary or higher education.

India's education system is referred to as ten + two + three system. The first ten years of education are, theoretically, obligatory, and are referred to as 1st to 10th standard.

Primary and secondary education in India is segregated as Primary (1st standard to 4th standard), Upper Primary (5th standard to 7th standard), Lower Secondary (8th standard to 10th standard) and Higher Secondary (11th and 12th standard).

- **Per capita weekly consumption of a specific food items in household (in gms) :** Dietary patterns of the members of the household are derived from the household questionnaire where an adult respondent (preferably mother of the adolescent) was asked about how many times weekly the item was consumed in the household and the quantity of the item procured weekly. Then these weekly quantities were divided by the number of household members to calculate the household per capita weekly consumption of dairy and meat, fish and egg food items. Vegetable oil and ghee consumption were estimated using the same method, in grams. In short, this was derived by dividing the weekly purchase of that item by the number of family members.
- **Per capita weekly consumption of meat/egg/fish (in gms) :** This was derived by combining consumption of meat (in gms), eggs (1 egg \approx 50 gms), and fish (in gms).
- **Per capita weekly consumption of dairy products (milk, yoghurt) (in gms) :** Animal protein food items, the quantity of yoghurt (curd) and milk was combined into dairy consumption (cheese is not part of the traditional diet in this region) in litres.
- **Per capita weekly consumption of dal/pulses (in gms) :** Dal/Pulses are a source of vegetable protein. Quantity of consumption of pulses per week in grams was considered for the study.
- **Per capita weekly consumption of vegetable oil (in gms) :** The cooking oil usually used in the area is peanut oil. Quantity of consumption of oil per week in litre was considered for the study.
- **Per capita weekly consumption of ghee (in gms) :** Ghee is clarified butter made of cow's or buffalo's milk. The quantity of consumption of ghee per week in grams was considered for the study.
- **Household size:** Number of persons living together in one house.

- **Addiction:** An individual was classified as current user of tobacco, if there was at least one positive answer to the question “Do you currently use any substances ? (smoke, chew tobacco, gutka)”. Gutka is a powdery, granular substance, within moments of chewing, it mixes with saliva and may impart upon its user a “buzz” somewhat more intense than that of tobacco chewing. Similarly, the current use of alcohol was defined.
- **Symptoms of RTIs :** The girls were asked in the survey whether they had started menstruating. If the respondent was post-menarcheal, she was asked about experiencing symptoms related to reproductive tract infection during the last 12 months such as white discharge, itching in genital area, leakage of urine, increased frequency of urinating, burning sensation while urinating. If a respondent reported having experienced any symptoms of the reproductive tract infection, she was considered as having suffered or suffering from symptoms suggestive of RTIs.
- **Age at menarche :** Age at menarche as retrospectively informed by the girl herself and recorded in full years. The question asked in the adolescent questionnaire was “how old were you when menstrual period started ?”
- **Level of maturation :** The physiological, mental and social effects of menarche are partly abrupt and partly start to influence a girl’s health status gradually (Apter et al. 1980). Here we divided girls into two categories according to the level of maturation: 0 = menarche within the previous 12 months or earlier and 1 = menarche more than 12 months from the survey.
- **Studying :** A question “Are you currently studying ?” was used to derive the current status of attending school or studying.
- **Able to speak to parents :** Parental support is shown to be an important determinant of mental wellbeing also in slum conditions (Fatori et al. 2013). The relationship was examined by the question ‘Can you talk to your parents about things that concern you?’ The answers were categorised as those who answered ‘always’ or ‘often’, and those who gave other answers.

4.4 Statistical analyses

The data were summarised using descriptive statistics such as mean, standard deviation, range, and percentiles. The data included more than one adolescent from the same households in studies I, II and III. The data on adolescents from the same household might be correlated and, hence, regression models used for the analysis included a household-specific random effect.

(McCulloch et al. 2008). Age-adjusted means were obtained using linear regression of each variable of interest (denoted by y) over independent variable (denoted by x) using the linear mixed effects model :

$$y_{ih} = b_0 + b_1 x_i + u_h, i = 1, \dots, n_h, h = 1, \dots, H,$$

where b_0 and b_1 are the fixed-effects, x is the age, ϵ is the random error due to the model and u is the household-specific random effect. Both ϵ and u are assumed to be independent and normally distributed.

For the analysis of binary dependent variables such as stunting and thinness, mixed effects logistic regression models were used. The mixed effects logistic regression model specified in terms of the log odds is given as follows :

$$\log \frac{P(y_{ih} = 1 / x_{ih}, b, h)}{P(y_{ih} = 0 / x_{ih}, b, h)} = b_0 + b_1 x_{1i} + b_2 x_{2i} + \dots + b_p x_{pi} + u_h, i = 1, \dots, n_h, h = 1, \dots, H,$$

where y is a response variable (stunting or thinness), $x = (x_1, x_2, \dots, x_p)$ is a vector of p independent variables, $b = (b_0, b_1, \dots, b_p)$ is a vector of fixed effects and u is the household-specific random effect.

Study I : Anthropometric data was restricted to the age group 10-18 years since the growth curves from India are available up to the age of 18 years. For the same reason, the blood pressure profile was also obtained for this age group.

Pearson's correlation coefficient was obtained to study the association between two variables of interest.

For the analysis of stunting and thinness, mixed effects logistic regression models applied.

Study II : One of our main hypotheses of interest was to test whether mental wellbeing was associated with SBP and DBP. These associations were studied using generalised linear mixed effects model. Two linear mixed effects models were fitted for each SBP and DBP. The first model included age, sex and mental wellbeing score. In the second model, other factors such as family history of blood pressure, which were expected to associate with blood pressure, were added. To account for the effect of age on height and BMI, stunting and thinness were used in the second model in place of height and BMI.

Study III : Age at menarche was the variable of interest in this study. The association between age at menarche and household-wise use of sources of animal protein and oil and fat was examined by using mixed effects linear regression models.

Study IV : Only post-menarcheal girls from the inner-city slum were included in this study. Limiting the sub-study to only the inner-city slum helped to control the effect of the living environment and the potentially different exposure to reproductive health experience and information. The dependent variable was symptoms of RTI, and independent variables were stunting, studying, able to speak to parents, level of maturation, parental education, hypertension, poverty status, and high or low mental wellbeing score. These variables were summarised by estimating the proportions of a high mental wellbeing score and corresponding confidence intervals for each category of the independent variables. A logistic regression analysis was carried out using the independent variables that showed differences in the proportions of a high score between their categories. The predictive probabilities for a post-menarcheal girl with a high score and given specific values of the independent variables were calculated.

All analyses were performed using the statistical computing environment *R* and the regression were implemented using the *glmer* function from the package *lme4* of *R* (R core team, Bates, M. Maechler, B. Bolker, and S. Walker 2013).

5. Results

5.1 Household characteristics

The information gathered from the house to house survey helped to know the lifestyle, actual economic and environmental condition of people living in slums. Discussions and meetings with people of slums were conducted to explain the purpose of the survey. Before conducting this survey, some eminent social workers and doctors were invited to deliver lectures in the slums to explain the usefulness of this work, which created a supportive atmosphere at the time of the data collection. The investigator visited the slums daily for interacting with adolescents and their mothers. If they had some difficulty in answering questions in the questionnaires, the investigator discussed with them and checked the data filled in by the surveyors. It generated faith and comfort amongst adolescents, and their mothers for answering the research questions and confidence in surveyors for filling out the questionnaires.

The total number of members in the households in which the adolescents under study live was 3060, of which 433 (14%) were children, 545 (18%) adolescents (between 10 to 19 years) and 2082 (68%) adults. Nearly 85% of the families had lived in the same household in the same slum for more than 10 years. A negligible proportion of the members of the households had faced food security and scarcity problems in the past 4 weeks.

The slum population was homogeneous with regards to its native place Maharashtra, and mother tongue Marathi. The major religion was Hindu (87%), followed by Muslim (10%), Buddhism (2%), and other religions (1%).

The castes observed in the slums were Scheduled Caste (SC, 40%), Scheduled Tribes (ST; 32%), Open Caste (10%), Other Backward Class (OBC, 9%) and other caste (9%). Of the total houses under study, 74% were owned, while 26% of houses were rented by the parents of the adolescents.

The houses had one or two rooms with a carpet area of about 10 m² (one room, 44%) or about 20 m² (two rooms, 56%). The houses had overcrowded populations with a household crowding index ranging from 2.5 to 5. The average number of Wage-earning members in these households was 1.5. On average, each household had one or two Wage-earning members.

51% of the houses were Kaccha houses (made out of mud), 45% were Pucca houses (cement houses) while the rest, 4 % , were Semi-Pucca (floor made of cement and walls of mud and bricks) houses. 97% of the houses utilised the shared toilet facility provided by the Nashik Municipal Corporation. The rest, 3%, did not have any toilet facilities. 59% of the households had one tap for drinking water, while the rest used the public tap facility provided by the municipality as a source of water for drinking. Kerosene lanterns were used as a source of light in 5% of the households, while the remaining 95% had been given a temporary or permanent source of electricity.

Table 2 : Socio-economic characteristics of the parents of the adolescents under study in the two slums

Variables under study	Outskirts slum	City slum	p-value**
	Sundarnagar	Phulenagar	
No. of adolescents	233	312	---
Household size (%)			0.671
- 4 or less	36	39	
-5	26	29	
-More than 5	38	32	
Below poverty line* (%±SE)	76±2	55±2	< 0.001
Per Capita income in INR (Mean ± SE)	780±178	1023±126	< 0.001
Mother's education			< 0.001
-Primary or no education (n (%))	155(68)	107(34)	
-Secondary or higher (n (%))	72(32)	205(66)	
-Missing no. of observations	6	0	
Father's education,			< 0.001
-Primary or no education (n (%))	114(52)	51(17)	
-Secondary or higher (n (%))	107(48)	242(83)	
-Missing no. of observations	12	19	
Family history of hypertension (%±SE)***			
Yes	4±1	14±1	< 0.001

* Below poverty line if the monthly per-capita income in the household is below INR 961 per person per month for urban Maharashtra, India (Government of India, press note).

** Using chi-square test.

*** If either of the parents was known to have high blood pressure then family history was coded as yes

Table 2 gives an idea of the overall picture of the socio-economic conditions of the parents of the adolescents under study in the two slums. The majority of the households were with a household size five or more. The median household size for outskirts slum was six, while that of the city slum was seven. The mean per capita income per month was also different in the slums. The mean per capita income per month was observed as INR 960 and INR 843 for the families of the boys and girls, respectively, which puts 60% boys and 68% girls below the

poverty line. Occupations of the parents of the adolescents' were reported. In outskirts slum, 60% mothers were at home, 13% worked as household helpers, 13% worked as labourers and 14% were in the service sector. In the city slum, 68% mothers were at home, 10% worked as household helpers, 10% worked as labourers and 12% were in the service sector.

In the outskirts slum, 45% of the fathers were labourers, 22% had small businesses, and 9% were in the service sector, while 24% were unemployed. In the city slum, 41% of the fathers were labourers, 22% had small businesses, and 11% were in the service sector, while 26% were unemployed.

5.2 Characteristics of the adolescents

- There were 269 boys and 276 girls in the sample size of 545 adolescents. The average age of the adolescents included in the study, from the outskirts slum was higher than the city slum (p value < 0.001). The average number of currently studying adolescents in the outskirts slum was lower than the city slum (p value < 0.001). In the outskirts slum, 10% of the adolescents had no education, while in the city slum it was only 2%.
- In outskirts slum, 29% of the adolescents were engaged in earning money, while in the city slum, 25% were engaged in earning money. A larger proportion of the households were below the poverty line in the outskirts slum as compared to the city slum (Table 2)

In both the slums, nearly all the adolescents collected information (recent events in politics, science and happenings around) from newspapers and television. It was noted that in the outskirts slum, 95% collect information about political activities and new scientific developments from their peer group, while in the city slum, it was 48% of the adolescents. In the city slum, there was one school, one library and a common meeting place. Combined results for the two slums indicated that of the boys, 25% were smokers and 24% and 35% chewed tobacco or gutka, respectively. There were no girl smokers in this sample. Among girls, 7% either chewed tobacco or used gutka. No boy had tried to stop smoking tobacco in the past 12 months.

In the adolescent questionnaire, questions on the presence of addiction in father, mother, siblings and friends were asked from the adolescents (Table 3).

Table 3 : Proportion of presence of addiction (%± SE) in the family members and friends reported by the 545 adolescents under study

n=545	Smoke tobacco	Chew tobacco	Chew *Gutka	Drink alcohol	Use Narcotics
Father	21.3±1(398)	69.9±3.5(135)	60.5±2(184)	35.9±2(331)	1.1±0.4(506)
Mother	0.7±.03(514)	19.2±1.8(422)	9.3±1(475)	0.35±0.2(517)	0.2±0.1(517)
Siblings**	1.8±1(509)	7.8±3.7(482)	10.6±1(474)	0.35±0.2(517)	0(519)
Friends #	2.0±1(506)	4.1±2.7(495)	4.7±0.9(496)	1.1±0.4(513)	0(519)

*Gutka is a powdery, granular substance, within moments of chewing, it mixes with saliva and may impart upon its user a “buzz” somewhat more intense than that of tobacco chewing.

** Presence of addiction in one or more siblings is considered here.

Presence of addiction in one or more friends is considered here.

Large number of missing values in the data

Table 3 shows addiction in adolescents’ family members and friends. Fathers had a high prevalence of addiction in all the categories compared to the other family members. Tobacco and Gutka chewing is more prevalent in both the father and the mother. Chewing tobacco was the most common among mothers. Tobacco and gutka seemed to be major addiction problems in the slums.

Table 4: Health status reported by adolescents (N = 545)

	Outskirt slum (N = 233)	City slum (N = 312)	p-value
Described general health as (last 12 months before survey) (n (%))			0.260
- Very good	117(51)	173(56)	
- Good	104(45)	131(42)	
- Moderate	10(4)	7(2)	
- Missing values	2	1	
Suffering from a chronic illness diagnosed since the last five years (n (%))			0.963
- Yes	8(3)	12(4)	
- No	222(97)	297(96)	
- Missing values	3	3	
Serious injuries in the last 12 months before survey (n (%))			<0.001
- Yes	16(9)	6(2)	
- No	164(91)	299(98)	
- Missing values	53	7	
Malnourishment (diagnosed by a doctor) in the last 12 months before survey (n (%))			0.569
- Yes	6(2)	13(4)	
- No	222(98)	294(96)	
- Missing value	5	4	
Visited a doctor in the last 6 Months (n (%))			<0.001
- Did not visit	72(32)	107(35)	
- Visited once	83(37)	165(53)	
- Visited twice	62(27)	31(10)	
- Visited three times or more	10(4)	6(2)	
- Missing values	6	3	

Table 4 presents the general health status reported by the adolescents in the two slums.

- Of the boys 2.7% (7 out of 259) and of the girls 4.6% (12 out of 258) had malnutrition.
- Of the boys 7.9% (18 out of 226) had had serious injuries, while 1.2 % (3 out of 237 girls) of
- The girls had had serious injuries. For the remaining variables shown in the above table, no
- Sex difference was observed.

From the literature, it was found that it was better to study the presence of reproductive tract infection for the girls who had their menstrual cycle for at least 1 year, which ensures regular menstrual periods. In the outskirts slum, 72%, while in the city slum 91% of the girls had onset of menarche at least 1 year prior to the survey.

5.3 Growth of the adolescents (Study I)

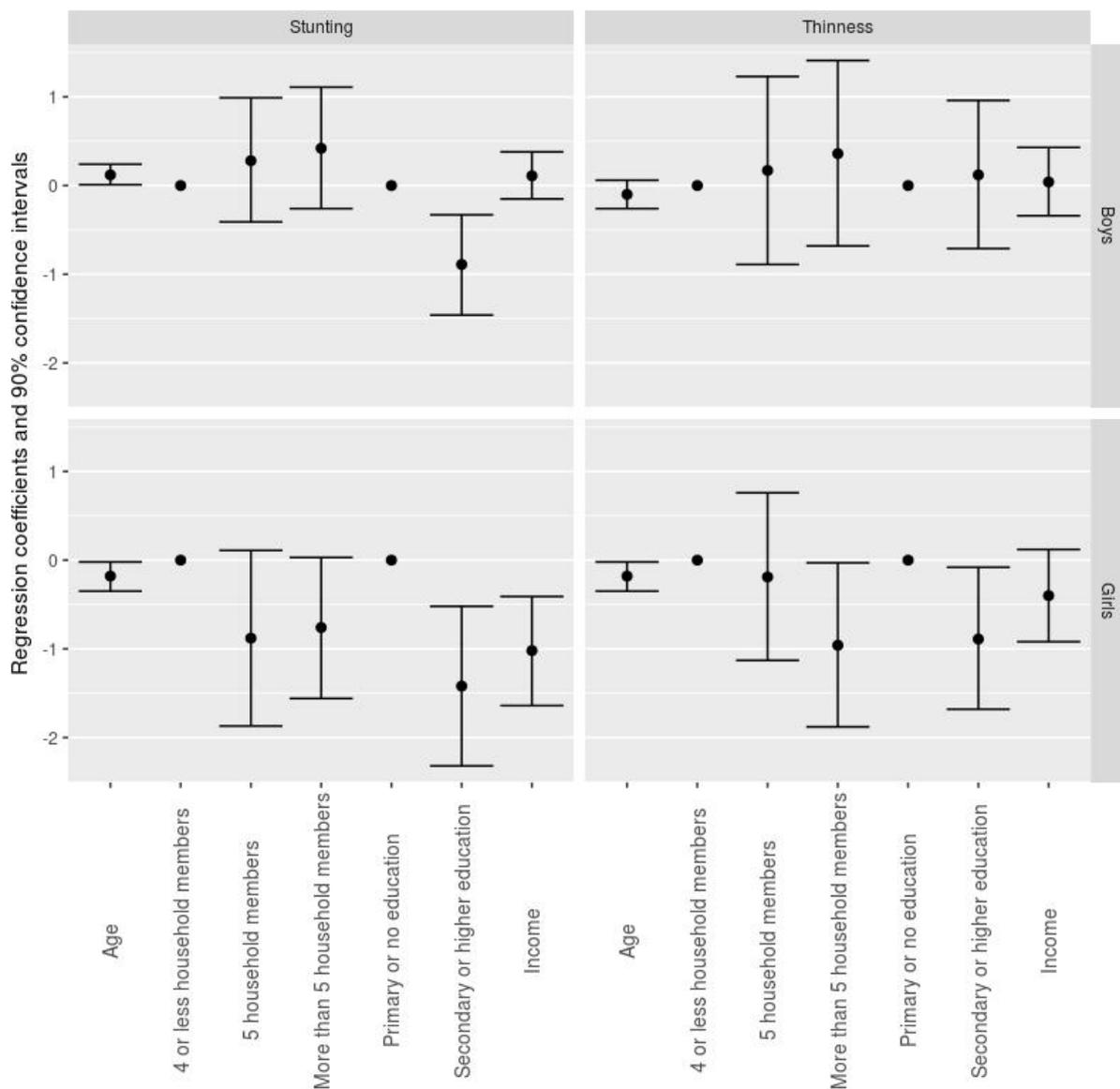
The analysis of anthropometric data was restricted to the age group of 10–18 years (boys = 257, girls =261, total = 518) since the growth curves from India are available up to the age of 18 years.

- The mean height and weight increased with an increase in age in both sexes.
- The trends of height for girls and boys were similar until the age of 12 years, and the mean weight of girls showed a similar pattern until the age 14 years.
- From the age of 13 years on, boys were taller than girls.
- The present study population had lower median values (about 10 cm for height and 3 kg/m² for BMI) for all ages compared to the WHO reference population.
- Stunting showed an increasing trend with age among boys and a decreasing trend among girls.
- The proportion of stunted boys was lower compared to girls at ages 10 and 11 years, after which the trend was reversed.

The regression analyses for stunting (Table 4, Study I) and thinness (Table 5, Corrigendum to Study I), were carried out by adding the independent variables of household size, mother's education, income, and dietary data on consumption of oil, egg/meat/fish and dal/pulses, one by one to the model in addition to age. The results of Table 4 and 5 are also presented as bar plots in Figure 3.

Income was significantly associated with stunting among girls, with a ten-standard deviation unit increase in income, reducing the odds of stunting by 20% among girls. There was no significant association of dietary data observed in this study. For girls, age, mother's education, and income remained significant and, in addition, household size was significantly associated with stunting. When moving from a household size of four or less to more than five, the odds of stunting among girls were reduced by 70%.

Figure 3: Association between stunting and age in years, household size, mother's education and income in INR for boys and girls, and also between thinness and these factors using mixed effects logistic regression model. Regression coefficients and 90% confidence intervals are shown.



Odds of thinness versus normal BMI were analysed under the regression models with age as an independent variable and then each of the other variables was added to the model. None of the independent variables showed significant association with thinness among boys (Table 5 above and Figure 3). For girls, age, mother's education, and household size were significantly associated with thinness. When mother's education increased from primary or no education to secondary or higher education, the odds of thinness versus normal BMI were reduced by 58%. One unit (1 year) increase in a girl's age reduced the odds by 17%, while moving from a household size of 4 or less to more than 5 reduced the odds by 62%. Once again, dietary data did not show any significant effect. In the multivariate analysis including all the independent variables, age and mother's education remained significant for girls with similar effects as described above.

5.4 Mental wellbeing and blood pressure profile (Study II)

The analysis was restricted to the age group of 10–18 years (boys = 257, girls = 261, total = 518). Nutritional status of adolescents was one of the factors under study.

- The factors like the scenario of different types of pain in last 30 days, moods, presence of
- positive attitude and tendency of friendship which were taken in to consideration to evaluate
- mental wellbeing score of adolescents under study (Table 1, Study II).

The categorical variables were summarised by providing proportions, and blood pressure was summarised by sample mean and standard deviation, for the three categories of mental wellbeing score (Table 1, Study II). Girls had a higher mental wellbeing score compared to boys. The nutritional status of 91% of the adolescents was normal, and there were no differences observed in the mental wellbeing scores with regard to the nutritional status. However, the percentage of stunting was the highest (22%) among those with a low-score as compared to the other mental wellbeing score categories (10% and 12% in the mid- and high-score categories, respectively). The prevalence of current use of tobacco (20%) and alcohol (17%) were the lowest among those with a high-score. The same applies to the health-related problems, higher the score lower the prevalence of problems. Adolescents with higher mental scores tended to have a higher percentage of both parents with secondary or higher education (61% mothers and 82% fathers) compared to lower score (46% mothers and 59% fathers).

Association of blood pressure and mental wellbeing was considered in the study. Mean systolic and diastolic blood pressure values decreased as the mental wellbeing score increased and the prevalence of prehypertension was lowest among those with a high mental wellbeing score. The overall prevalence of prehypertension (which included prehypertensive and hypertensive) among the study subjects was 20%, of which 7% of all were prehypertensive or hypertensive.

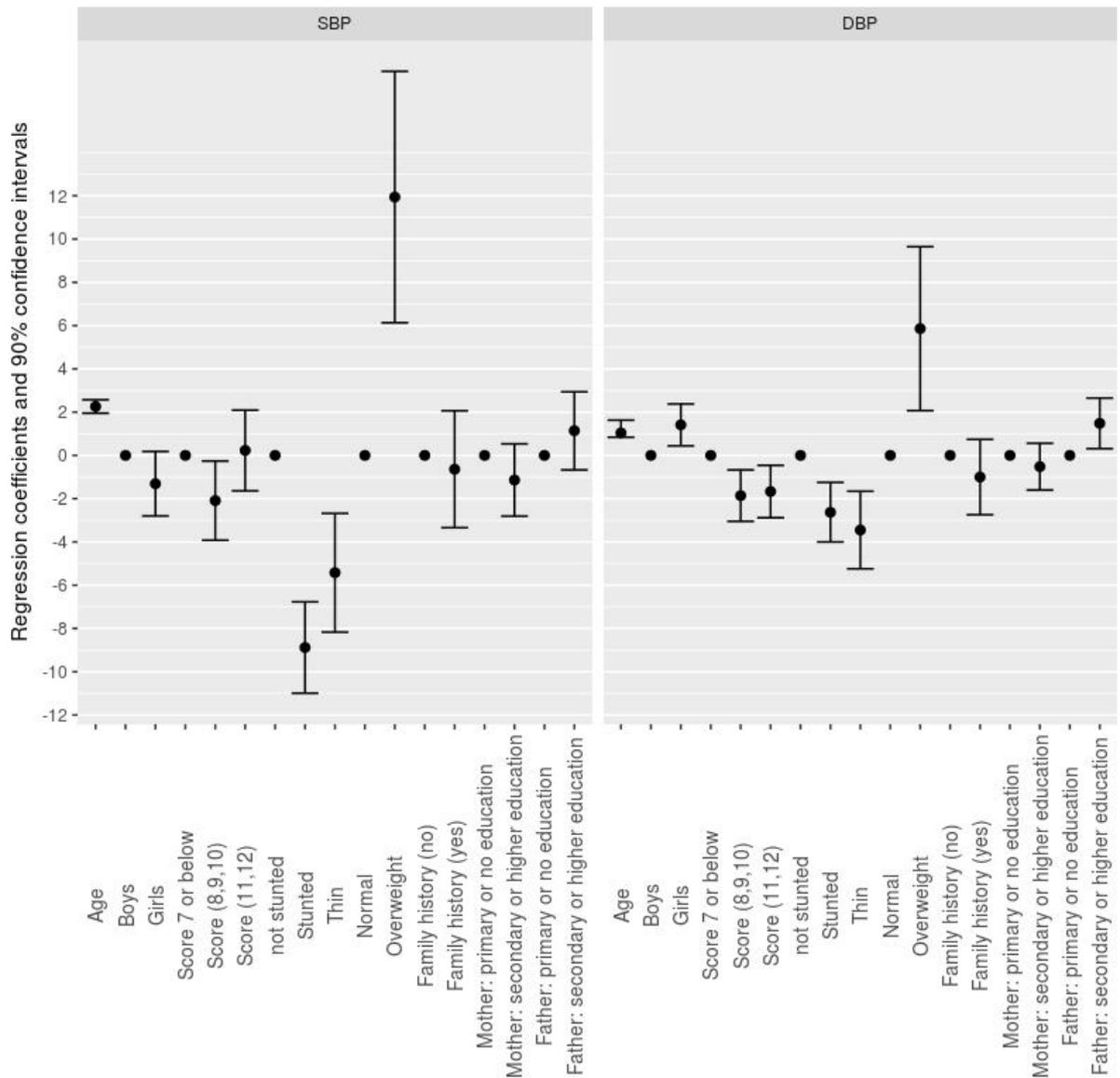
For boys in the age group of 10 - 18 years, an average difference between one-year age group in SBP was 2.0 mm Hg and in DBP was 1.2 mm Hg. The same for girls were 1.8 mm Hg and 0.9 mm Hg.

When the mental wellbeing score was used as an independent variable in a regression model, it was adjusted for age and sex, with systolic blood pressure as a dependent variable. These results are also presented as bar plots in Figure 4, no significant association was observed. But when diastolic blood pressure was used there was significant decrease in the DBP with an increase in the mental wellbeing score range, and sex was also significant with girls having a higher DBP than boys.

SBP and DBP increased when moving from the normal to the overweight category, while it decreased when moving to the thin category. Stunted adolescents tended to have a lower SBP and DBP compared to other adolescents.

When moving from a low mental wellbeing score to a mid score, the SBP and DBP decreased, and the same was observed for a high score. The DBP was higher when moving from primary or no education of the father to secondary or higher education. The father's education showed a positive association with DBP of adolescents in this data.

Figure 4 : Association between systolic blood pressure (SBP) and mental wellbeing score, thinness and parents' education, family history of hypertension, age in years and sex, and also between diastolic blood pressure and these factors using mixed effects linear regression model. Regression coefficients and 90% confidence intervals are shown.



5.5 Age at menarche (Study III)

Out of the 272 girls, 160 had attained menarche at the time of the survey (Table 1, Article III). The mean age at menarche was 13.7 years (SD 0.962) and the median 14 years. Eight percent had reached menarche before they turned 13, and 4% after their 16th birthday.

The economic level among the households of the adolescent girls was low. Two thirds of the surveyed post-menarcheal girls' households were below the poverty line of the Indian Planning Commission for urban Maharashtra 2009 - 10 (Government of India, press note 2012, Dhambare 2012). Of all the mothers of the adolescent girls, nearly every other one and 29% of the fathers had no or below primary education (descriptive statistics not shown). The most common caste categories of the respondents were Scheduled Tribes and Scheduled Castes, the two lowest categories in the social hierarchy; 73% of all respondents originated from these two categories.

Only three variables examined separately produced statistically significant regression coefficients: per capita vegetable oil consumption (- 1.485), ghee consumption (5.025), and height (0.032).

In order to analyse dietary variables more closely, a linear regression analysis was carried out in three different models (Table 2, Study III).

Vegetable oil (2.160) and meat, fish and eggs (- 0.572) consumption had negative regression coefficients, but of these, only oil was significantly associated with the age at menarche. The regression coefficient of ghee was strongly positive (6.665) and also appeared highly significant (Table 2, Study III). Because dietary patterns related to the consumption of food that are important sources of protein and fat could potentially relate to the total energy intake and anthropometric status of the girl, height and BMI were added in the second model.

Height was slightly positively associated with the age at menarche (coefficient 0.034), and the BMI did not show an association with the age at menarche in the model (coefficient 0.011). The coefficients of vegetable oil and ghee remained relatively unchanged even when anthropometric characters were taken into account.

The third model examined whether adding some basic socioeconomic variables could change the association between the consumption of oil and ghee and the age at menarche. Caste

categories were analysed, using Scheduled Caste as the reference population. The coefficients of oil and ghee consumption and height did not change considerably and remained significant. Caste categories did not produce statistically significant coefficients, although the coefficient of Scheduled Tribes shows some indication of a positive relationship with the age at menarche compared with girls of Scheduled Castes. The per capita household income was also tried out in the model as a potential confounder of the association between oil and ghee consumption and the age at menarche, but the regression coefficient became very close to zero, as it also did in univariate regression.

In a linear regression model controlling for the selected dietary variables, anthropometric status and social background, the consumption of vegetable oil and ghee remain statistically significantly associated with the age at menarche. This relationship was inverse so that girls from households consuming more vegetable oil tended to have their first menses earlier. Those consuming more ghee appeared in turn to have a tendency to have their menses later. The association between these two types of fats and age at menarche did not disappear when bringing into the model anthropometric status or the socioeconomic situation of the household. However, the relationship between ghee consumption and age at menarche should be interpreted cautiously due to skewness of the distribution. Of all the households of the girls, 53% did not consume any ghee at all.

5.6 Mental wellbeing and self-reported symptoms of reproductive tract infections (Study IV)

In the present study, the analysis was restricted to girls who had attained their menarche at the time of the survey. Only post-menarcheal girls from the city slum were included. Limiting the sub-study to only the city slum helped to control the effect of the living environment and the potentially different exposure to reproductive health experience and information. The number of girls included in the multivariate analysis was 91.

The main source of information about menstruation for 88% girls was their mother. 9.4% obtained information from their close relative or neighbours or friends, and 0.6% girls did not receive any information at all. The remaining 2% girls were informed by their teachers. All the girls had a menstruation period with premenstrual syndrome (pain in abdomen, body pain, and headache). The most common menstrual problem was dysmenorrhea (51%). Most of the girls (87%) used old plain cloth as absorbent during menstruation, and 13% used commercially

available sanitary napkins. During the last one year low cost pads have been made available in India by government organisations to reduce reproductive diseases.

Nearly every other post-menarcheal girl expressed having suffered from at least one symptom suggestive of a reproductive tract infection. The proportion of girls with menarche of more than 12 months from the survey was 53%. The level of maturation gave an indication of potentially being related to a worsening mental wellbeing score. The prevalence of stunting was 8%, and it was seen in the data that these girls had a lower mental wellbeing score. As age increases, it was seen that the mental wellbeing score was worsening. For stunted girls, the mental wellbeing score was low.

One in four girls was prehypertensive; hypertension nevertheless was not associated with the mental wellbeing score. The response about being able to speak to the parents, which was used as an indicator of parental support, did not reflect on the mental wellbeing score. Of the socioeconomic variables (mother's education, father's education and whether below poverty line), only 58% of the girls living below the poverty line gave an indication of being related to lower mental wellbeing. 25 girls out of the total 49 girls living below the poverty line gave an indication of being related to a lower mental wellbeing score.

The proportions of having a high mental wellbeing score showed clear a difference between the categories of the following variables: symptoms of reproductive tract infection, level of maturation, stunting, and below the poverty line. These selected variables were included in the logistic regression model.

Using logistic regression, the two most evident variables lowering the odds for having high mental wellbeing were 'being stunted' (OR 0.14, CI 0.01-0.86) and 'reporting symptoms suggestive of reproductive tract infections' (OR 0.35, CI 0.15 – 0.79). The level of maturation and living in a household below the poverty line also seemed to lower odds for good mental wellbeing; however, the confidence intervals were quite wide (Table 2, Study IV).

Reported symptoms of reproductive tract infections reduced the predictive probability of having good mental wellbeing, both among stunted and not stunted girls (Table 3, Study IV). The predictive probability of a high mental wellbeing score was the highest for a girl who was not stunted and had no symptoms suggestive of reproductive tract infection, and was the lowest for a girl who was stunted and had symptoms of reproductive tract infection.

6. Discussion

6.1 Summary of findings

Looking at the family data of the adolescents, most of the adolescents live in overly crowded households and areas. Crowding has been linked to a number of biological mechanisms that can increase both the risk and the intensity of infection and mental or psychological health. About two thirds of the study population was below the poverty line of the state of Maharashtra (below per capita income of INR 961 or US\$ 15). One out of three household members was a wage-earning member. Nearly 85% of the families had stayed in the same household of the same slum for more than 10 years. This shows that there is not enough economic progress of the people living in these households to move into a better locality or household. In this study sample, about half of the adolescents stayed in Kaccha houses that are made from mud, which is also a source for infectious diseases.

The nutritional status and possible associated factors of adolescents from an economically deprived slum population constitutes a sizeable proportion of the overall Indian urban population. With increasing urbanisation, this population is likely to grow.

The prevalence of stunting and thinness were lower using the Indian reference population compared to that of the WHO. The prevalence of stunting was higher among boys than girls after the age of 11 years and also the prevalence of thinness was higher among boys at all ages.

Stunting was more prevalent than thinness in the study subjects, and boys suffered more from it than girls. The mother's education was strongly associated with both stunting and thinness in both sexes. Household size and income were significantly associated with the nutritional status of girls.

With regard to BMI-for-age, a high proportion (90%) of the study population had a normal nutritional status. The overall prevalence of being overweight (1% boys and 2% girls) and thinness (8%) were low compared to other studies on urban children in India (Khadilkar et al. 2009, Thakor et al. 2000). In this paper, no association was observed between dietary factors under study and stunting and thinness. Unfortunately, the total diet of the participating adolescents could not be evaluated in the current study. It could be assumed that the study population was rather homogeneous with regard to the lifestyle.

To the best of our knowledge, this is the first study where the association between mental wellbeing and blood pressure of underprivileged adolescents in India has been examined. This study suggests that the known factors of age, height and BMI, but not family history, influence blood pressure among adolescents. This may be partly explained by the low proportion of family history of high blood pressure in the current study population. An analysis of normal and non-stunted adolescents revealed that adolescents with mid- and high- mental wellbeing scores had significantly lower DBP compared to those with low-scores. The mother's education was associated with decreased DBP.

The adolescents studied here formed a socio-economically and culturally relatively homogenous and starkly underprivileged population in terms of caste, parental education, income and food consumption. The majority of people received very little animal protein, and the consumption of vegetable protein was low. The staple diet in the slums consists of unleavened wheat bread and cooked rice, eaten with vegetable curry or homemade pickle or chutney and occasionally dal (thick stew prepared of split pulses). Some households also prepare unleavened bread of pearl millet (bajri).

- Age at menarche in the present study was higher than even in some other Indian studies of
- underprivileged populations (Bagga 2000, IIPS 2010). BMI was not associated with age at menarche, while height was associated with it.

Oil consumption and age at menarche were associated in the present study, but the type of the oil made a difference to the direction of the effect. Vegetable oil was negatively related to age at menarche, while ghee, butter oil, was positively related to it. The evidenced relationship between oil and age at menarche was contrary to many studies in high-income countries that have generally failed to establish a relationship (Rogers et al. 2010).

It is hard to say whether earlier or late menarche is desired in this population since the association between gain in height and menarche remain rather unclear. It is believed that if menarche is late then there may be some extra years for growth. However, if dietary changes, such as increase in the intake of oils, are recommended then they should be implemented in early childhood so that the (genetically potential) growth in height is achieved by the time menarche is reached. In these cases, menarche may be earlier.

In the present study in post-menarcheal adolescent girls living in slum conditions, we found

evidence of an association between poor mental wellbeing and having symptoms of reproductive tract infections.

The high prevalence of RTIs could be due to the self-reported symptoms of RTIs and the questions might not have been well understood by the girls. Moreover, common problems such as itching in genital area, leakage of urine, increased frequency of urinating, burning sensation while urinating are due to hygiene and the girls living in the slums have limited access to water and sanitation.

6.2 Strengths and limitations of the study

The important strength of the present house-to-house interview based survey was that the local and well-respected social workers, with training in collection of data for different surveys, conducted this survey. Initially, surveyors were given training for collection of the data for this survey. Camps were conducted in the slums under the supervision of expert doctors; technically trained nurses measured anthropometric factors and took blood pressure measurements. Both adolescents who were attending school as well as not attending school were reached. The overall response rate and item-response rates were high. To the best of our knowledge, this is the first survey of its kind focusing on adolescents living in urban slums gathering information on measurements of growth, blood pressure, mental wellbeing, reproductive health, and lifestyle factors, simultaneously.

The present study was a small cross-sectional study and had several limitations that are worth mentioning. It covered adolescents residing in only two slums from a city and city outskirts, and hence, it may not be a representative sample of the adolescent slum population of India. More slums from within the city limit and outskirts would be required to estimate the population-level characteristics of adolescents residing in these areas. However, small studies such as the present one are useful to bring out the important aspect of research questions, and bigger studies can be built on the findings.

Due to the limited resources, the adolescents from non-slum areas of the city could not be covered, and hence, comparisons of adolescents living in and outside of slums could not be carried out, though that would have been of great interest. For example, comparisons of adolescents living in slums and non-slums with respect to mental wellbeing and other socio-

demographic factors would be of interest. Only two measurements of blood pressure were taken in the present study as against the recommendation of three measurements.

The dietary data were restricted to the invalidated food frequency questionnaire, from which only food consumption data was available, not that of nutrient intake. In spite of these limitations, the study points towards an emerging public health issues of stunting, mental wellbeing and hypertension among adolescents, and it brings out the determinants which might be helpful in planning interventions and guidance to parents and community, in general.

This study derives from self-reported symptoms of reproductive tract infections and not from bacteriological specimen. Self-report is found to be an inaccurate basis for determining the prevalence of gynaecological morbidity among adult women in India. (Bhatia et al. 1995, Koenig et al. 1998, Patel et al. 2006). It is necessary to take this into consideration when interpreting the study results.

The association between symptoms suggestive of reproductive tract infections and poorer mental wellbeing in this study sample cannot be directly interpreted as a sign of a causal relationship - reproductive health problems causing poor mental health - although such a causal, relationship can exist. Those having poor mental wellbeing can possibly report reproductive health symptoms as an idiom of mental distress, or end up in behavioural patterns that lead to poorer reproductive health conditions.

The other major problem observed through this study, was the use of chewing tobacco and gutka among boys, girls and their parents in the slums. The prominent presence of all types of addictions were observed in fathers. Most mothers were working outside the house and hence, were not available to attend to the needs of their children. In Indian culture, such responsibilities are still with the mothers. Children are vulnerable to substance abuse, malnutrition and possible drop-out from schools.

6.3 Comparison with the results of other studies

Compared to other studies from urban adolescents from India, this population had a higher prevalence of stunting but not thinness (Haboubi 2009, Rajaretnam et al. 2012, Patil et al. 2013, Kumarvel et al. 2014). However, this trend was reversed when compared to school children (10–17 years) from the rural area of Wardha, Maharashtra, and the rural area of northern

Karnataka (Taksande et al. 2008, Rajaretnam 2012). The phenomenon may also indicate that the diet of these households was deficient in protein-rich foods. The growth reference curves for India were derived using apparently healthy affluent Indian children (Khadilkar et al. 2009), and the present slum population seemed to have a lower anthropometric profile in comparison.

The prevalence of stunting was higher than the prevalence of thinness among boys and girls. This could be because girls were nutritionally better off than boys (Venkaiah 2002). This highlights a less researched question about boys suffering growth-related issues and possibly nutritional deficiency as the focus of such research has been mostly on girls and women.

The association between stunting and thinness with higher income and more family members among girls is in line with the rural Wardha study (Deshmukh 2006) and Gaiha's study (Gaiha et al. 2014).

The mother's education was found to be an important factor affecting stunting as well as thinness among boys and girls in accordance with other studies (Das et al. 2005, Deshmukh et al. 2006, Abudayya et al. 2007).

There is evidence that blood pressure measured in adolescence will predict future blood pressure, and adolescents with blood pressure levels in the higher portion of the blood pressure distribution curve tend to maintain that position over time (Lewington et al. 2002).

The average SBP and DBP were lower than those reported in earlier studies (Chiolero et al. 2007, Delpeuch 1997, He, Q. et al. 2000). However, apart from diastolic blood pressure, the results for girls were comparable to the school children from Kerala (He Q. et al. 2000). A positive correlation between blood pressure and anthropometric measurements (height, weight, BMI) is observed in the current study. These correlations are higher compared to rural school children (combining boys and girls) of Wardha (Khadilkar et al. 2009) and lower compared to the urban study from Kolkata (Greden 2001).

There is a wide variation in the prevalence of hypertension in children in India ranging from a high of 11% to as low as 0.46% (Mohan et al. 2004, Singh et al. 2006, Kumar et al. 2012). The prevalence of pre-hypertension was high compared to other studies from India. However, it was comparable to that observed in developed countries, e.g. USA (18.9%) and Switzerland (24.7%) (McNeice et al. 2007, Chiolero et al. 2007). This also requires immediate action from

the community health workers and primary health centres. The adolescents who were identified as pre-hypertensive could be checked by a health worker regularly for a proper follow-up. A factor affecting blood pressure and worth discussing here is the mental wellbeing. A recent study on adolescents from the US brings into focus the maintenance of a healthy body mass index and control of hypertension in improving the mental health of younger populations in the US (Tevie et al. 2015). Both high blood pressure and depression are very common disorders (Murray et al. 2013). Adolescents living in slums may face challenges and feel deprived of basic needs. A regular evaluation of their mental status and counselling would give them a platform to talk openly about their problems and help to be in a better frame of mind. This will help to keep their mental wellbeing score in the higher range. An analysis of normal BMI-for-age score and non-stunted adolescents revealed that mid- and high-mental wellbeing scores had significantly lower DBPs compared to those with a low-score.

The reproductive development among girls from slums showed delay in the age of menarche compared to other Indian studies (Bagga et al. 2000, IIPS 2010). The poor economic situation and diet deficient in protein and fat may be responsible for this. The age at menarche was significantly associated with height, but not with BMI for study participants. Some studies have pointed out that the percentage of body fat may be a more relevant factor than BMI or other anthropometric measures in explaining age at menarche in India (Rao et al. 1998). Further, the association of consumption of oil and ghee with the age at menarche gave a further indication of the potentially divergent roles of different fats in relation to the age at menarche and more widely to women's reproductive health. The reason behind the type of fat consumed makes a difference for reproductive development and women's health, in conditions of low energy intake and common undernutrition is still being studied. The potentially changing dietary patterns accompanied by economic development may lead to unexpected consequences for the health of those who have suffered from food scarcity for generations. Because oil is a highly valued food item, improvement in the income level among the economically poor leads to replacement of cereals by oils and other food items (Jacobsen et al. 2007). No relationship between the consumption of animal protein and the age at menarche was in line with Wiley's (Wiley 2011) study in the US, and a number of older studies in high income countries (Moisan et al. 1990, Maclure et al. 1991) as well as studies in China (Zhu et al. 2006), Turkey (Atay et al. 2011) and Iran (Ramezani et al. 2013).

Continuing with the problems related to the menstruation and reproduction, nearly every other post-menarcheal girl in the sample expressed having had at least one symptom suggestive of RTIs during the last 12 months. The prevalence of self-reported RTI symptoms among Indian women has been found to be 11-18% in nationally representative studies and 40-57% in small-scale studies. Data on the prevalence of symptoms suggestive of RTIs among unmarried adolescent Indian girls remains limited, as most studies have concentrated on married women (Sabarwal et al. 2012). Among urban slum-dwelling married women 39% had reported having had symptoms during the preceding 12 months (Hegde 2013). In a sub-nationally representative study, 13% of unmarried adolescents had had symptoms during the preceding three months (Sabarwal et al. 2012). Even when taking into account differences in reporting periods and populations, the prevalence of reported symptoms suggestive of reproductive tract infections (48%) in this study was relatively high by Indian standards. The comparison to other studies is also limited by the fact that studies have examined somewhat different lists of symptoms.

The two variables importantly associated with poorer mental health were stunting and reported symptoms suggestive of reproductive tract infections. The interrelation between mental health and reproductive health among South Asian adolescents has rarely been empirically studied, apart from those who are sexually or physically abused (Patel et al. 2001). Socio-cultural norms in India expect unmarried girls and women to be sexually inexperienced and ignorant. If they face any sexual or reproductive health problems, it is difficult for them to reveal the situation to family members, friends or health-care service providers, which rarely meet the requirements of confidentiality (Mmari et al. 2014). South Asian adolescent girls' mental wellbeing is potentially jeopardised by the unhappy combination of vulnerable reproductive health (Bhatia et al. 1995), lack of personal autonomy (Ram et al. 2014) and social taboos of seeking treatment (Koenig et al. 1998).

After controlling for other potential factors, this study did not find evidence of a relationship between consumption of other food items than fats and age at menarche.

The result related to the absence of association between the consumption of animal protein and age at menarche is in line with the study in US (Wiley 1999).

7. Summary and Conclusions

This study has brought out the important areas of health of adolescents living in challenging slum conditions. The study topics clearly explained why anthropometric measurements, blood pressure measurements and evaluation of reproductive health factors were necessary to observe frequently for mental wellbeing in adolescents. This message is very important in the long run.

The age-specific stunting among boys was clearly noticeable. Boys with a higher prevalence of stunting compared to girls might have suffered from high levels of chronic undernutrition, a consistent lack of consumption of required nutrients both in quantity and quality, and partly from untreated infections. Proper care is needed for growing boys to meet their nutritional requirements according to age. The mother's education was highly significant in reducing stunting among both sexes and hence, educating the mothers of adolescents about their nutritional needs may help in improving adolescents' anthropometric profile and future health. A longitudinal study looking at anthropometry and dietary intake data would be needed for planning of a proper nutritional intervention for urban slum populations to overcome the problem of stunting.

Household size and income were significantly associated with the nutritional status of girls. Educating mothers about the nutritional needs of adolescents may help to improve adolescents' anthropometric profile and future health. No association was observed between dietary data and growth status. One reason for this could be that the study population was rather homogeneous with regard to the food habits and to some extent, lifestyle. Another obvious explanation is that not very detailed food consumption and nutrient intake data could be collected.

An analysis of normal and non-stunted adolescents revealed that mid- and high- mental wellbeing scores were associated with significantly lower DBP compared to low-scores. Adolescents having educated mothers seem to have lower DBPs.

Chronic and acute undernutrition was prevalent in the present study population. BMI was associated with blood pressure among largely undernourished adolescents, even in a population such as slum-dwelling adolescents that does not suffer from a high prevalence of overweight and obesity.

In this study of post-menarcheal adolescent girls living in slum conditions, we found evidence of an association between poor mental wellbeing and self-reported symptoms of reproductive tract infections. Poverty and stunting are both related to poor socioeconomic status and bring forward the close interaction between material wellbeing, somatic health and mental wellbeing, also in slum environments.

The present thesis highlights that a significant proportion of youth has health-impacting behaviours and conditions that affect their growth and mental wellbeing. The health problems in adolescents are showing an increasing trend, and are interlinked, and they must be taken care of in near future.

- Boys with a higher prevalence of stunting compared to girls might have suffered from high levels of chronic undernutrition, a consistent lack of consumption of required nutrients both in quantity and quality, and partly from untreated infections.
- The importance of mental health management in adolescents is realised here mainly due to the association of mental wellbeing with stunting, blood pressure, and RTIs.
- The high prevalence of pre-hypertension (including hypertension) among the study participants is alarming. The relationship between high BP and depression is thought to be bidirectional by many researchers (Tevie et al. 2015). However, it is natural to expect that mental anxiety is likely to increase BP, at first temporarily, but it may later on develop into permanent hypertension, but it is not very clear how the relationship works the other way around. Throughout adulthood, blood pressure is strongly and directly related to vascular as well as overall mortality (Lewington et al. 2002). Early diagnosis, treatment, and follow-up of the hypertensive cases and preventive methods may decrease future morbidity and mortality.
- Intake of dietary fats and foods that are important sources of protein among underprivileged households in India is low and may be reflected in the relatively late age at menarche. The potential differences in the association between various types of fatty acids, energy intake and age at menarche in conditions of undernutrition requires further prospective study.

- Provision of youth-friendly reproductive health services for adolescents in slums would be important to reduce stress related to reproductive health problems. Attention should be paid to the mental wellbeing of school-going adolescents in developing educational practices.
- The present analysis highlights that a significant proportion of adolescents has health-impacting behaviours and conditions that affect their growth and mental wellbeing. Their health problems need careful evaluation and follow-up. Further, proper guidance to the mothers would help enhance their health status.
- This is the first empirical study to point to the interrelationship between mental wellbeing and symptoms of RTIs among unmarried, underprivileged Indian adolescent girls. The results stress the necessity to consider this association when planning ways to improve and secure young people's health status in developing countries. The proportion of young people among the global population is growing, and reproductive and mental health issues will be among the most important health concerns to tackle by national and international health initiatives.
- Health service development in growing informal urban agglomerations in India should provide integrated mental and reproductive health services to adolescents. The importance of a holistic approach to health should be acknowledged; those adolescents who suffer from stunting and live in households below the poverty line are also the most vulnerable to poor mental wellbeing. Securing employment and proper income for the underprivileged will also lead to lesser anxiety and depression among adolescents. What is needed is adolescent-friendly health care, instruction on child nutrition to reduce stunting and better food security for the poor.

8. Implications for future research

After completion of this study, the immediate implications for the future could be clearly seen and are noted below:

- Government policies towards mid-day meal and other means of providing food to adolescents seems to be working. However, there is a need to educate parents about nutritional needs of adolescents so that there can be appropriate redistribution of the resources spend on food.
- A policy for providing sanitation and clean water to everyone need to be implemented more rigorously.
- High level of addiction in parents and also the adolescent boys needs policy action.
- Policies that would involve fathers in child caring are required to be framed in India.
- A longitudinal study looking at anthropometry and food intake data would be needed for planning a proper nutritional intervention for urban adolescent slum populations to bring in behavioral change in diet and address the problem of stunting in a more coherent manner. The intervention should also include education for parents, especially mothers, in the nutritional needs of adolescents.
- A larger study assessing the role of mental health and blood pressure is called for. If this is implemented properly then it would help in building health promotion and disease prevention measures for mental health and hypertension.
- A study evaluating knowledge, attitude and practice of sexual and reproductive health will help develop a proper intervention to make behavior changes and safe practices towards sexual and reproductive health.

- To achieve wholesome adolescent health, a multidimensional approach is needed covering all the adolescent health problems with special emphasis on mental health, behavior change, communication towards healthy lifestyle and positive social environment to acquire life skills.

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