This is the accepted manuscript of the article, which has been published in Child care health and development. 2018, 44(4), 531-538. http://dx.doi.org/10.1111/cch.12567

Depressive symptoms are common among rural Malawian adolescents

Tiina Teivaanmäki[1,2], Yin Bun Cheung[1,3], Kenneth Maleta[4], Mihir Gandhi[5,3], Per Ashorn[1]

[1] Center for Child Research, University of Tampere, Faculty of Medicine and Life, Tampere, Finland

[2] Helsinki University Hospital, Department of Pediatrics, Helsinki, Finland

[3] Centre for Quantitative Medicine, Duke-National University of Singapore Medical School, Singapore, Singapore

[4] School of Public Health and Family Medicine, College of Medicine, University of Malawi, Blantyre, Malawi

[5] Singapore Clinical Research Institute, Singapore, Singapore

Abstract

Background

Depressive conditions cause about 25 million disability adjusted life years in low-income countries annually. The incidence of depression rises after puberty, and the young age distribution in these countries may cause a high burden of adolescent depression. We aimed to assess the prevalence of reported depressive symptoms among rural adolescents in Malawi. Additionally, we assessed the association between birth weight, childhood growth, gender, and pubertal maturity and depressive symptoms.

Methods

We followed 767 children from the foetal period until 15 years of age. We used the Short Mood and Feelings Questionnaire (SMFQ) to examine reported depressive symptoms at 15 years. Anthropometry was conducted at one, 24, 120, and 180 months of age. Using multiple imputation to handle missing data, we performed regression models with imputed data and confounders to assess associations between the independent variables and depressive symptoms. As a sensitivity analysis, we ran the same regression models with participants with no missing data.

Results

Some 523 participants were seen at 15 years. The mean SMFQ score was 15, and 90% (95%CI 87–92%) of the participants scored ≥11 points, the traditional cut-off for significant depressive symptoms. Some 12% (95%CI 9–15%) scored ≥20 points. Birth weight, growth, gender, and pubertal maturity were not associated with the SMFQ score in the primary imputed analyses. In the sensitivity analysis, birth weight was associated with the SMFQ score in all models.

Conclusions

The prevalence of reported depressive symptoms was high among the studied population. It is uncertain how well the traditional cut-off of 11 points identifies children with clinically significant depressive symptoms in our sample. Our data do not support a hypothesis of an association between growth, gender, or pubertal maturity and depressive symptoms. Nevertheless, our results highlight the importance of the awareness of mental health problems in low-income countries.

Introduction

Depression caused 26.5 million disability adjusted life years in low-income countries in 2004 (World Health Organization; WHO, 2008). Estimates of the prevalence of adolescent depression vary. In Sub-Saharan Africa, approximately 14% of children suffer from psychological disorders (Patel et al. 2007, Cortina et al. 2012). The incidence of depression rises after puberty, and the young age distribution in low-income countries results in a high burden of adolescent depression. However, child and adolescent mental health services are rarely available (Angold et al. 1998, Patel et al. 2007).

The aetiology of adolescent depression is multifactorial. It has been mostly studied in developed countries, and evidence from low-income countries is scarce. In addition to a genetic tendency for the disease, social disadvantage, parental mental disorders, female gender, and experiences of violence are related to depression (Patel et al. 2007). Low birth weight, growth failure, and malnutrition early in life may also contribute to later depressive symptoms, but the significance of childhood growth is unknown (Galler et al. 2010, De Mola et al. 2015, Walker et al. 2007). Since brain development continues throughout childhood, malnutrition may lead to neurodevelopmental disorders into adolescence (Thompson 2001, Teivaanmaki et al. 2015). The incidence of depression rises after pubertal onset, and the timing of puberty is influenced by possible growth failure and catch-up growth (Proos 2012, Angold et al. 1998). The stage of pubertal maturity is therefore important when evaluating the association between growth and depression. To our knowledge, this information has not been collected before.

The primary objective of this study was to describe the prevalence of reported depressive symptoms at 15 years of age in a rural Malawian cohort. The secondary objective was to assess the associations between birth weight, growth, gender, and pubertal maturation and depressive symptoms in adolescence, particularly in the Sub-Saharan adolescent population.

Participants and Methods

Study design

This prospective cohort study was conducted in Lungwena, Mangochi District, Southern Malawi. Covering approximately 100km^2, the study area included 26 villages and 23,000 inhabitants, who were mostly Muslims of the Yao tribe. The literacy rate was low, and the main income sources were farming and fishing.

The study cohort was enrolled between June 1995 and August 1996. It comprised 795 mothers who attended the antenatal clinic at Lungwena Health Centre during their pregnancies (Maleta et al. 2003). These pregnant women carried 813 foetuses, and the number of children born live was 767 (Figure 1). There were 759 children alive after the first day of life, and these cohort members were followed up until 15 years of age. Anthropometry was conducted at birth and at 1, 24, 120, and 180 months (15 years), and depressive symptoms and pubertal maturity were examined at 15 years. We then examined the magnitude of depressive symptoms and assessed the association between the change in length-/height-for-age (LAZ/HAZ) at the aforementioned age intervals, birth weight, gender, and pubertal maturation and depressive symptoms.

Ethical approval for the Lungwena Child Survival Study (LCSS) was obtained from the National Health Science Research Committee in Malawi (HSRC 93/94) and the College of Medicine Research and Ethics Committee (P04.05.314). Informed consent was obtained from each guardian at the beginning of the study and again from each guardian and adolescent before the visit at 15 years.

Data collection

We used the Short Mood and Feelings Questionnaire (SMFQ) to assess the adolescents' reported depressive symptoms at 15 years. A public health scientist translated the questionnaire from English to the Yao language, and a psychologist back-translated it to English. The translation was then revised until the two versions corresponded. The SMFQ provides a reliable measure of depressive symptoms in children of a variety of ages (Angold et al. 1995, Turner et al. 2014). It contains 13 questions with three response options, true (2 points), sometimes true (1 point), and not true (0 points). The range is 0–26 points, and a score ≥11 is suggested to refer to significant depressive symptoms. The SMFQ includes individual items such as "I felt miserable or unhappy" or "I didn't enjoy anything at all". With the generally used 11-point cut-off, the specificity of the questionnaire is 83% for identifying those who meet the ICD-10 criteria for depression, and the sensitivity is 71% (Turner et al. 2014). One third of the participants were considered to have fluent literacy skills (as evaluated by a data collector via a reading test) and self-administered the questionnaires. The rest were interviewed. The pubertal stage of the participants was assessed by trained research assistants at 15 years with the Tanner classification (Tanner 1962). It includes five stages (I–V) for pubic hair development for both sexes, and genitalia development for boys and breast development for girls. Cognitive capacity, which was added in one of the models as a potential intermediate variable, was examined with Raven's Coloured Matrices (Raven et al. 1998, Teivaanmäki et al. 2016).

Using three different regression models, we studied the association of birth weight and height gain between one and 24 months, 24 and 120 months, and 120 and 180 months (15 years) and depressive symptoms at 15 years. The first weight measurement, taken during the first seven days of life, was used as a proxy for birth weight. It reflects foetal growth and possible adverse exposures during pregnancy. The three age intervals represent growth until the first 1,000 days of life, the latent growth period, and pre-pubertal and pubertal growth. Procedures for anthropometric measurements have been described previously (e.g. Maleta et al. 2003). Briefly, the data collectors measured the participants' weight during the first seven days and length at one month at their homes. Length was measured with locally constructed length boards. The measurements at 24 months were taken with a self-made height board at the participants' homes, and the measurements at 120 and 180 months were taken with a stadiometer (Harpenden, Holtain Limited, UK) at the study clinic. The study team calibrated the equipment weekly, and the data collectors were trained and retrained by the investigators at intervals of 1–36 months. Their work was also regularly monitored.

To derive length-/ height-for-age z-scores (LAZ/HAZ), we used the WHO Multicentre Growth Reference Study (WHO Multicentre Growth Reference Study Group 2006) for children at one and 24 months and the WHO Reference 2007 (De Onis et al. 2007) at 120 and 180 months. Reference values for supine length were used for the measurements at one month and standing height for ≥24 months. We used two closely aligned WHO references to cover the whole range of growth in length/height in the cohort. We generated the z-scores for anthropometric measurements using a Stata macro (Vidmar et al. 2013).

We added potential confounders and mediators to the regression models. The wealth index was assessed during pregnancy by interviewing the mothers. It summarizes the household ownership of radios, bicycles/tricycles, mattresses, and livestock ownership of land per person, and the number of family supporters. It was derived from factor analysis and categorized into three levels: poor (below the 40th percentile), middle (40th–80th percentiles), and rich (top 20th percentile). The gestational duration was estimated with a national chart for fundal height during the antenatal visits. Information about the timing of menstrual periods was not reliable, and ultrasound was not available (Kulmala et al. 2000).

Statistical analyses

We counted the boys’ and girls’ SMFQ scores separately. In the primary regression analysis, we used multiple imputation to impute missing data. All missing data in the independent and dependent variables and potential confounders were imputed for the 523 participants who attended the examination at 15 years. Multiple imputation by chained regression was used to allow for missing values in more than one variable (White et al. 2011). We used 50 sets of imputation (White et al. 2011) and the 50 sets of data were pooled using Rubin’s rule (Rubin 1987).

We assessed the associations between birth weight; linear growth from birth to 24 months, 24–120 months, and 120–180 months (15 years); and depressive symptoms at 15 years. Model 1 simultaneously included birth weight (grams), HAZ at one month (HAZ_1), 24 months (HAZ_24), 120 months (HAZ_120), and 15 years (HAZ_180) as exposure variables without any confounder adjustments. Model 2 was adjusted for gender, gestational duration (weeks), father’s occupation, father’s literacy, mother’s literacy, and the wealth index (Filmer et al. 2001). Model 3 was further adjusted for the Raven’s Coloured Matrices score at 15 years (Teivaanmäki et al. 2016, Raven et al. 1998) and pubertal stage. This model aimed to assess the potential role of cognitive function and pubertal maturity as intermediate variables through which HAZ might affect depression.

As a sensitivity analysis, we performed the same regression models with all the cohort members who had no missing values in any of the variables, without using multiple imputations. We performed all analyses using Stata 12.1 (Stata Corporation, College Station, TX, USA).

Results

Of the 767 infants, 759 survived the first day of life and were included in the cohort. After the first day, 171 (23%) died and 50 (7%) permanently dropped out prior to the follow-up at 15 years. After the deaths and dropouts, there were 538 participants in the 15-year assessments, of whom 523 had data in one or more of the outcome variables and were included in the imputed analyses. Of the 523 participants, 287 had missing values in one or more of the exposure or outcome variables. Thus, 236 participants with no missing values were included in the sensitivity analysis (Figure 1).

Among the 523 participants, the mean (SD) duration of pregnancy was 39.1 (3.3) weeks and the newborn weight was 3,110 (519) grams. Some 20% were born preterm (<37 completed gestation weeks), and 9% presented with low newborn weight (<2,500 g). The socio-demographic baseline characteristics were substantially similar for the participants and those excluded because of death, loss to follow-up, or missing data (Table 1).

Among the 523 participants undergoing anthropometry at 15 years, the mean (SD, range) SMFQ score was 15.0 (4.2, 0–26) points: 14.9 (4.0, 0–26) for male and 15.0 (4.4, 0–26) for female (p=0.72). Of all participants (n=458), 90% (95%CI 87–92%) scored ≥11 points. Corresponding figures for males and females separately were 92% (95%CI 88–95%; n=231) and 88% (95%CI 83–91%; n=227), respectively (Table 2). Over 12% (95%CI 9–15%; n=62) of the participants scored ≥20 points (Figure 2). The distributions of the scores are presented in Figures 2 and 3. Most of the SMFQ assessments (77%) were interviewer-administered. The mean HAZ (SD) was -1.7 (1.2) at one month, -2.9 (1.2) at 24 months, -1.7 (1.0) at 120 months, and -1.7 (0.8) at 15 years (Table 2).

In the regression analyses with the imputed data, when birth weight and HAZ at one month, 24 months, 120 months, and 15 years were simultaneously included in the analysis (Model 1), birth weight (gram) was not statistically significantly associated with SMFQ score (coefficient -0.87, p=0.133) (Table 3). Height gains between different time periods were not statistically significantly associated with SMFQ score. The coefficients were 0.11 (*p*=0.643) at 1 month, -0.12 (*p*=0.536) at 24 months, -0.03 (*p*=0.932) at 120 months, and 0.15 (*p*=0.559) at 15 years (Table 3). Similar results were found in Model 2, adjusted for the potential confounders, and in Model 3, further adjusted for Raven's Coloured Matrices and pubertal maturity (Table 3). Neither pubertal maturity nor sex were statistically significantly associated with depressive symptoms (Table 3).

In the sensitivity analyses with the completely observed data (n=236), birth weight (grams) was statistically significantly associated with SMFQ score in Model 1 (coefficient= -1.58, *p*=0.014), Model 2 (coefficient= -1.45, *p*=0.034), and Model 3 (coefficient= -1.38, *p*=0.048) (Table 3). Taller children had a lower SMFQ score with coefficients of -0.30 (*p*=0.235) at 24 months and -0.61 (*p*=0.155) at 120 months. However, taller children at 1 and 180 months had a higher SMFQ score with coefficients of 0.07 (*p*=0.785) and 0.68 (*p*=0.044), respectively (Table 3). Other than HAZ at 180 months, these associations did not reach statistical significance. This association was diluted and other results did not change when possible confounders and intermediate variables were included in the model (Models 2 and 3). Pubertal maturity and gender were not statistically significantly associated with depressive symptoms (Table 3). The results were similar when we further added the mode of administration to all the presented analyses (data not shown).

Discussion

The study's primary aim was to evaluate the prevalence of depressive symptoms among rural Malawian adolescents. In a cohort of 523 study participants, the prevalence of reported depressive symptoms was high. Based on the SMFQ score, over 90% of the participants scored ≥11 points, indicating adverse psychological symptoms. The secondary aim was to assess the association between birth weight, height gain in childhood, gender, and pubertal maturity at the time of the assessment and depressive symptoms at 15 years. In the imputed data analysis, these factors did not predict depression in the cohort. However, lower birth weight was associated with more frequent reported depressive symptoms in the complete data analysis. This association was consistent when possible confounders and intermediate variables were added to the model. Physically more mature participants had slightly more reported depressive symptoms, but this association did not reach statistical significance. Sex was not independently associated with depressive symptoms in any of the models.

The prevalence of reported depressive symptoms in our cohort was unexpectedly high. Turner and others have argued that the SMFQ may overestimate the prevalence of depression in individuals with lower educational attainment, but it is unlikely that over-estimation would explain such a high percentage of participants suffering from clinically significant depressive symptoms (Turner et al. 2014). Our study did not reveal obvious predictors for the high prevalence of depressive symptoms. In line with previous studies (Costello 2007, De Mola 2014), we found some signs of higher birth weight being associated with fewer depressive symptoms in adolescence. This may highlight the importance of intrauterine growth on later mental health. Our evidence is not conclusive, however, as the confidence intervals were quite wide and the association was not found in the imputed primary analysis. The difference in the results between these two analyses may be due to the cohort's large drop-out rate. Neither height gain during childhood nor gender explained the magnitude of depressive symptoms. According to Angold and others, pubertal maturity relates to depressive symptoms, especially in girls (Angold et al. 1998). There was some evidence of the effect of advanced puberty in our study, but the associations were not statistically significant. The reason for the absence of associations is not evident: it is possible that there are no associations. Alternatively, perhaps the high prevalence of depressive symptoms in our cohort leads to too little variation and the differences cannot be distinguished with the tool used. There may also be some characteristics in depression morbidity in low-income countries that differ from those in the West. Most of the evidence of the association between early growth and depression comes from developed countries (Costello 2007, De Mola 2014). It was not possible to investigate these potential differences in this study.

We believe that our results may be generalized to the target population. The anthropometric measurements used in this study were taken by trained data collectors with proper, regularly calibrated equipment. Participant characteristics were similar in the included and the excluded groups, with the exception of birth weight, which was lower in the excluded group. Average birth weight was within normal range in both groups, however, and there was no significant difference in the proportion of children with low birth weight. In additional analyses with all the original participants included, the results were similar.

This study has some limitations. The SMFQ has not been validated in our study setting; however, the questionnaire was carefully translated and back-translated until the translations matched. The concept and vocabulary concerning mental health may have been unfamiliar to the participants in the study site, considering the poor awareness of mental health problems and services. The SMQF was mostly administered by interview rather than self-administration. However, interviews tend to underestimate rather than overestimate the prevalence of mental health problems (Waal et al. 2012). Hence, the high prevalence of symptoms in our cohort is most likely not due to the questionnaires' mode of administration.

The SMFQ is widely used, including in low-income settings and among adolescents (Turner et al. 2014, Bjelland et al. 2002, Ali et al. 2016, Allison & Ferreira 2017). It has shown promise as a reliable and valid instrument for the assessment of depressive symptoms among adolescents in Bangladesh, but the study did not establish a cut-off score for classifying clinical depression status (Deeba et al. 2015). The traditionally used 11-point cut-off may be inaccurate in low-income settings. Most of the individual items in the SMFQ are unambiguous, but some may be understood as physical symptoms, and may be overrepresented in our sample because of poverty and a lack of resources. Therefore, one may argue that the traditionally used cut-off may be too low in this rural African setting. However, even if the cut-off was raised to as high as 20 points, approximately 12% of the participants would still be classified as having a high level of reported symptoms. We did not collect data on the mothers' depression or mental health, which may contribute to the depressive symptoms of the offspring (Patel et al. 2007). The SMQF was only administered at 15 years, not at any other time points. The weight measurements were taken during the first seven days of life, so they do not represent the birth weights exactly, but they do give a reasonable estimate of the size of the participants at birth.

Our findings highlight the importance of the awareness of depressive symptoms and resource allocation in low-income countries. Further research is needed to establish a cut-off score for clinically significant depressive symptoms in rural Malawi, and to understand the high scores reported in this cohort. It may also be necessary to use different tools. Possible differences in the associations between developed and low-income countries remain unknown.

References

Ali, G., Ryan, G. & De Silva, M. 2016, "Validated Screening Tools for Common Mental Disorders in Low and Middle Income Countries: A Systematic Review", *PLOS ONE,* vol. 11, no. 6, pp. e0156939.

Allison, A.C. & Ferreira, R.J. 2017; 2016, "Implementing Cognitive Behavioral Intervention for Trauma in Schools (CBITS) with Latino Youth", *Child and Adolescent Social Work Journal,* vol. 34, no. 2, pp. 181-189.

Angold, A., Costello, E.J. & Worthman, C.M. 1998, "Puberty and depression: the roles of age, pubertal status and pubertal timing", *Psychological medicine,* vol. 28, no. 1, pp. 51-61.

Angold, A., Costello, E., Messer, S., Pickles, A., Winder, F. & Silver, D. 1995, "Development of a short questionnaire for use in epidemiological studies of depression in children and adolescents", *International Journal of Methods in Psychiatric Research,* vol. 5, no. 4, pp. 237-249.

Bjelland, I., Dahl, A.A., Haug, T.T. & Neckelmann, D. 2002, "The validity of the Hospital Anxiety and Depression Scale: An updated literature review", *Journal of psychosomatic research,* vol. 52, no. 2, pp. 69-77.

Christian Loret de Mola, Luciana de Avila Quevedo, Pinheiro, R.T., Gonçalves, H., Gigante, D.P., Vieira dos Santos Motta, Barros, F.C. & Horta, B.L. 2015, "The Effect of Fetal and Childhood Growth over Depression in Early Adulthood in a Southern Brazilian Birth Cohort: e0140621", *PLoS One,* vol. 10, no. 10.

Cortina, M.A., Sodha, A., Fazel, M. & Ramchandani, P.G. 2012, "Prevalence of child mental health problems in Sub-Saharan Africa: A systematic review", *Archives of Pediatrics and Adolescent Medicine,* vol. 166, no. 3, pp. 276-281.

Costello, E.J. 2007, "Prediction from low birth weight to female adolescent depression: A test of competing hypotheses", *Archives of General Psychiatry,* vol. 64, no. 3, pp. 343.

de Mola, C.L. 2014, "Low birth weight, preterm birth and small for gestational age association with adult depression: Systematic review and meta-analysis", *The British Journal of Psychiatry,* vol. 205, no. 5, pp. 340.

De Onis, M., Onyango, A.W., Borghi, E., Siyam, A., Nishida, C. & Siekmann, J. 2007, "Development of a WHO growth reference for school-aged children and adolescents", *Bulletin of the World Health Organization,* vol. 85, no. 9, pp. 660-667.

Deeba, F., Rapee, R.M. & Prvan, T. 2015, "Psychometric properties of two measures of childhood internalizing problems in a Bangladeshi sample", *British Journal of Clinical Psychology,* vol. 54, no. 2, pp. 214-232.

Filmer, D. & Pritchett, L.H. 2001, "Estimating wealth effects without expenditure data –or tears: An application to educational enrollments in states of India.", *Demography,* vol. 38, no. 1, pp. 115-132.

Galler, J.R., Bryce, C.P., Waber, D., Hock, R.S., Exner, N., Eaglesfield, D., Fitzmaurice, G. & Harrison, R. 2010, "Early childhood malnutrition predicts depressive symptoms at ages 11-17", *Journal of Child Psychology & Psychiatry,* vol. 51, no. 7, pp. 789-798.

Kulmala, T., Vaahtera, M., Ndekha, M., Koivisto, A.-., Cullinan, T., Salin, M.-. & Ashorn, P. 2000, "The importance of preterm births for peri- and neonatal mortality in rural Malawi", *Paediatric and perinatal epidemiology,* vol. 14, no. 3, pp. 219-26.

Maleta, K., Virtanen, S., Espo, M., Kulmala, T. & Ashorn, P. 2003, "Timing of growth faltering in rural Malawi", *Archives of Disease in Childhood,* vol. 88, no. 7, pp. 574-8.

Patel, V., Flisher, A., Hetrick, S. & McGorry, P. 2007, "Adolescent Health 3 - Mental health of young people: a global public-health challenge", *Lancet,* vol. 369, no. 9569, pp. 1302-1313.

Proos, L. 2012, "Is early puberty triggered by catch-up growth following undernutrition?", *International Journal of Environmental Research & Public Health Electronic Resource],* vol. 9, no. 5, pp. 1791-809.

Raven, J., Raven, J. & Court, J. 1998, "Manual for Raven's Progressive Matrices and Vocabulary Scales. Section 2: The Coloured Progressive Matrices.", *San Antonio, TX: Harcourt Assessment.,* .

Rubin, D.B. 1987, *Multiple imputation for nonresponse in surveys,* Wiley, New York.

Tanner, J. 1962, *Growth at adolescence.* Blackwell Scientific Publications, Oxford.

Teivaanmäki, T., Bun Cheung, Y., Pulakka, A., Virkkala, J., Maleta, K. & Ashorn, P. 2016, "Height gain after two-years-of-age is associated with better cognitive capacity, measured with Raven's coloured matrices at 15-years-of-age in Malawi: Height gain is associated with cognitive capacity", *Maternal & Child Nutrition,* .

Teivaanmaki, T., Cheung, Y.B., Kortekangas, E., Maleta, K. & Ashorn, P. 2015, "Transition between stunted and nonstunted status: both occur from birth to 15 years of age in Malawi children", *Acta Paediatrica,* vol. 104, no. 12, pp. 1278-1285.

Thompson, R.A. 2001, "Developmental science and the media. Early brain development", *American Psychologist,* vol. 56, no. 1, pp. 5-15.

Turner, N., Joinson, C., Peters, T., Wiles, N. & Lewis, G. 2014, "Validity of the Short Mood and Feelings Questionnaire in Late Adolescence", *Psychological assessment,* vol. 26, no. 3, pp. 752-762.

Vidmar, S.I., Cole, T.J. & Pan, H. 2013, "Standardizing anthropometric measures in children and adolescents with functions for egen: Update", *Stata Journal,* vol. 13, no. 2, pp. 366-378.

Waal, M.W.d., Weele, G.M.v.d., Mast, R.C.v.d., Assendelft, W.J.J. & Gussekloo, J. 2012, "The influence of the administration method on scores of the 15-item Geriatric Depression Scale in old age", *Psychiatry research,* vol. 197, no. 3, pp. 280-284.

Walker, S.P., Chang, S.M., Powell, C.A., Simonoff, E. & Grantham-McGregor, S.M. 2007, "Early childhood stunting is associated with poor psychological functioning in late adolescence and effects are reduced by psychosocial stimulation", *Journal of Nutrition,* vol. 137, no. 11, pp. 2464-9.

White, I.R., Royston, P. & Wood, A.M. 2011, "Multiple imputation using chained equations: Issues and guidance for practice", *Statistics in medicine,* vol. 30, no. 4, pp. 377-399.

WHO Multicentre Growth Reference Study Group. 2006, "WHO Child Growth Standards: Length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age: Methods and development. Geneva: World Health Organization.", .

World Health Organization. WHO, 2008. "The Global Burden of Disease 2004 Update. ", .

Key messages:

- Reported depressive symptoms are common among rural Malawian adolescents.
- Intrauterine growth may affect later mental health.
- Height gain in childhood, gender, and pubertal maturity at the time of the assessment did not predict depressive symptoms at 15 years of age.
- Awareness of depressive symptoms and the allocation of resources to mental health problems in low-income countries should be increased.

Figure legends:

Figure 1. The flow of study participants.

Figure 2. The association between SMQF score cut-off and the proportion of participants categorized as having a positive screening test result. The error bars indicate 95% confidence intervals for the proportion.

Figure 3. Short Mood and Feelings Questionnaire score for those boys and girls who were examined at 15 years. The red line is the traditional cut-off (11 points) for clinically significant depressive symptoms.

Table 1. Participant characteristics.

Variables	Included (n=523)	Excluded[a] (n=235)	*p*-value
Gender, Male % (n)	49 (259)	55 (130)	0.133
Mean birth weight[b], g (SD)	3,110 (519)	2,990 (485)	0.015
Low birth weight[b,c] %, (n)	9 (30)	12 (18)	0.222
Mean gestational age, weeks (SD)	39.1 (3.3)	39.1 (3.2)	0.971
Preterm births (<37 gestational weeks), % (n)	20 (103)	19 (42)	0.678
Wealth index, % (n)			
Poor	38 (194)	44 (97)	
Middle	39 (201)	37 (82)	0.351
Rich	23 (116)	20 (44)	
Father's occupation, % (n)			
Fisherman	40 (208)	35 (78)	
Other	22 (112)	26 (59)	0.420
Trader	19 (99)	19 (42)	
Farmer	19 (97)	20 (45)	
Father's literacy, Literate, % (n)	42 (218)	44 (99)	0.623
Mother's literacy, Literate, % (n)	14 (70)	15 (33)	0.674

a) Excluded because of death, loss to follow-up, or missing values. The final numbers of participants in the comparison vary between 496 and 759.

b) Measured at ≤7 days of age.

c) Low birth weight <2,500g.

Table 2. Summary of the independent and dependent variables of the participants who were examined at 15 years.

	n	Mean (SD)	*p*-value	Participants with SMFQ score ≥11 clinically significant depression (SMFQ score ≥11) n (%)
SMFQ	509	15.0 (4.2)		458 (90)
male	250	14.9 (4.0)		231 (92)
female	259	15.0 (4.4)	0.72*	227 (88)
Birth weight (grams)	348	3,110 (520)		
**HAZ_1	426	-1.7 (1.2)		
**HAZ_24	475	-2.9 (1.2)		
**HAZ_120	475	-1.7 (0.8)		
**HAZ_180	522	-1.7 (1.0)		

*The comparison between male and female was done with the *t*-test.

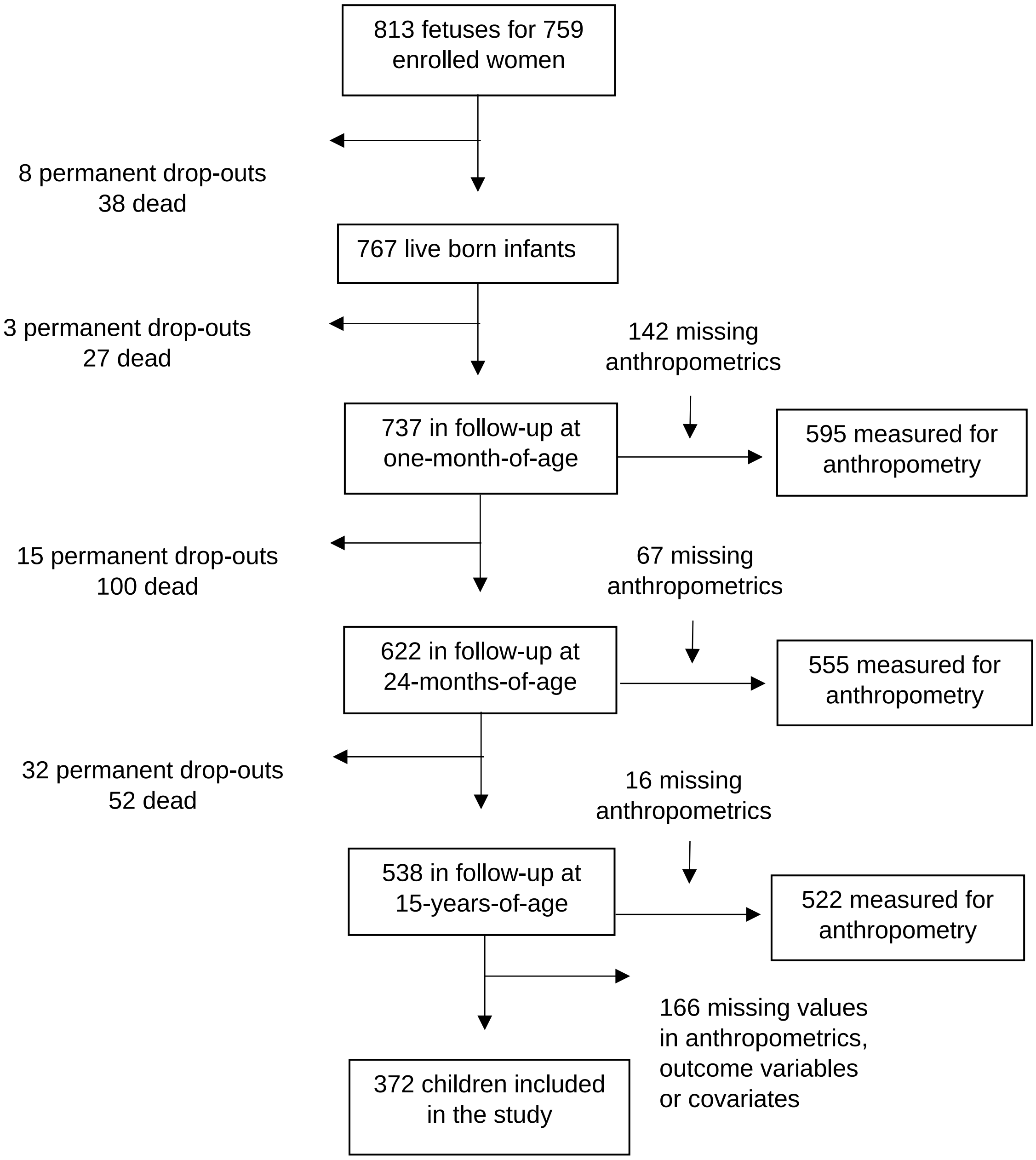
**HAZ= height-for-age.

Table 3. The association between birth weight and linear childhood growth and depressive symptoms at 15 years.

Regressor	SMFQ score					
	Model 1 Regression coefficient [95%CI], *p*-value		Model 2[a] Regression coefficient [95%CI], *p*-value		Model 3[b] Regression coefficient [95%CI], *p*-value	
	Observed (n=236)	Imputed (n=523)	Observed (n=236)	Imputed (n=523)	Observed (n=236)	Imputed (n=523)
Birth weight (grams)	-1.58 [-2,824– -328], 0.014	-0.87 [-2,003–267], 0.133	-1.45 [-2,794– -114], 0.034	-0.79 [-2,027–453], 0.212	-1.38 [-2,738–-13], 0.048	-0.72 [-1,967–524], 0.254
HAZ_1	0.07 [-0.45–0.59] ,0.785	0.11 [-0.34–0.60], 0.643	0.01 [-0.53–0.55], 0.978	0.07 [-0.41–0.56], 0.765	-0.01 [-0.56–0.53], 0.963	0.06 [-0.42–0.54], 0.800
HAZ_24	-0.30 [-0.79–0.19], 0.235	-0.12 [-0.52–0.27], 0.536	-0.27 [-0.78–0.23], 0.290	-0.10 [-0.50–0.30], 0.624	-0.28 [-0.79–0.24], 0.289	-0.10 [-0.50–0.29], 0.608
HAZ_120	-0.61 [-1.44–0.23], 0.155	-0.03 [-0.61–0.60], 0.932	-0.5 [-1.56–055], 0.345	-0.10 [-0.85–0.66], 0.793	-0.53 [-1.60–0.53], 0.324	-0.15 [-0.90–0.61], 0.706
HAZ_180	0.68 [0.02–1.35], 0.044	0.15 [-0.37–0.64], 0.559	0.54 [-0.32–1.40], 0.216	0.21 [-0.40–0.83], 0.497	0.49 [-0.38–1.36], 0.267	0.16 [-0.46–0.78], 0.614
Female			0.33 [-1.01–1.67], 0.630	-0.29 [-1.28–0.69], 0.559	0.37 [-1.00–1.74], 0.596	-0.31 [-1.31–0.70], 0.550
Puberty					0.48 [-0.83–1.79], 0.471	0.82 [-0.11–1.75], 0.086

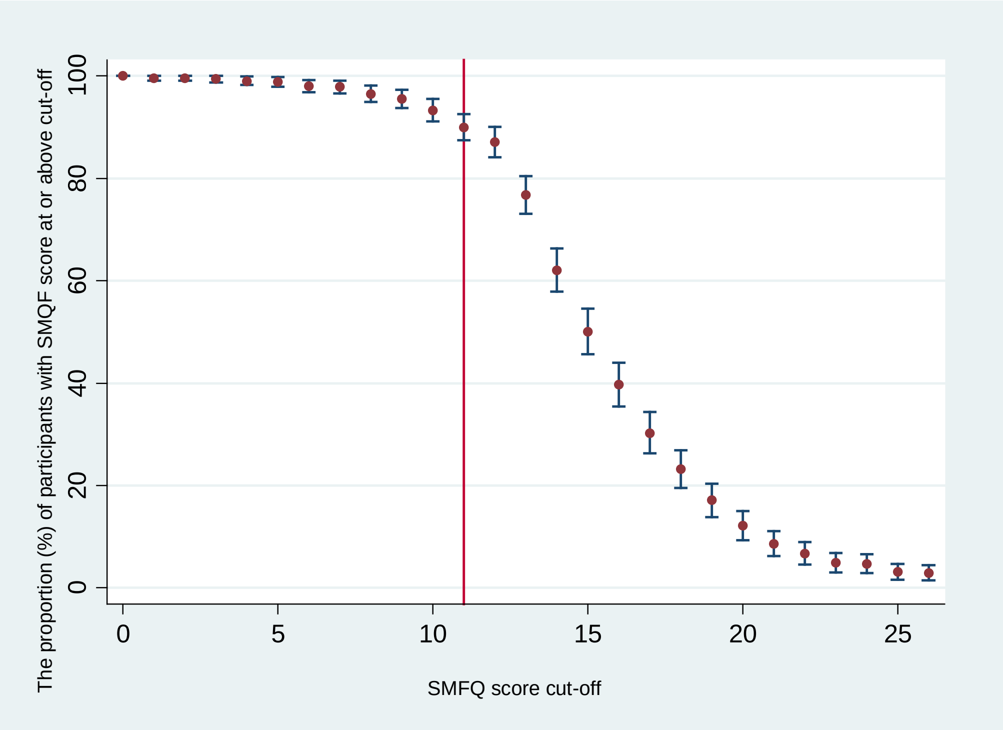
a) The confounders included in Model 2 are gender, socio-economic level, gestational duration, father's occupation, father's literacy, and mother's literacy.
b) The confounders and moderators included in Model 3 are gender, socio-economic level, gestational duration, father's occupation, father's literacy, mother's literacy, pubertal maturity, and the Raven's Coloured Matrices score.

Figure 1.



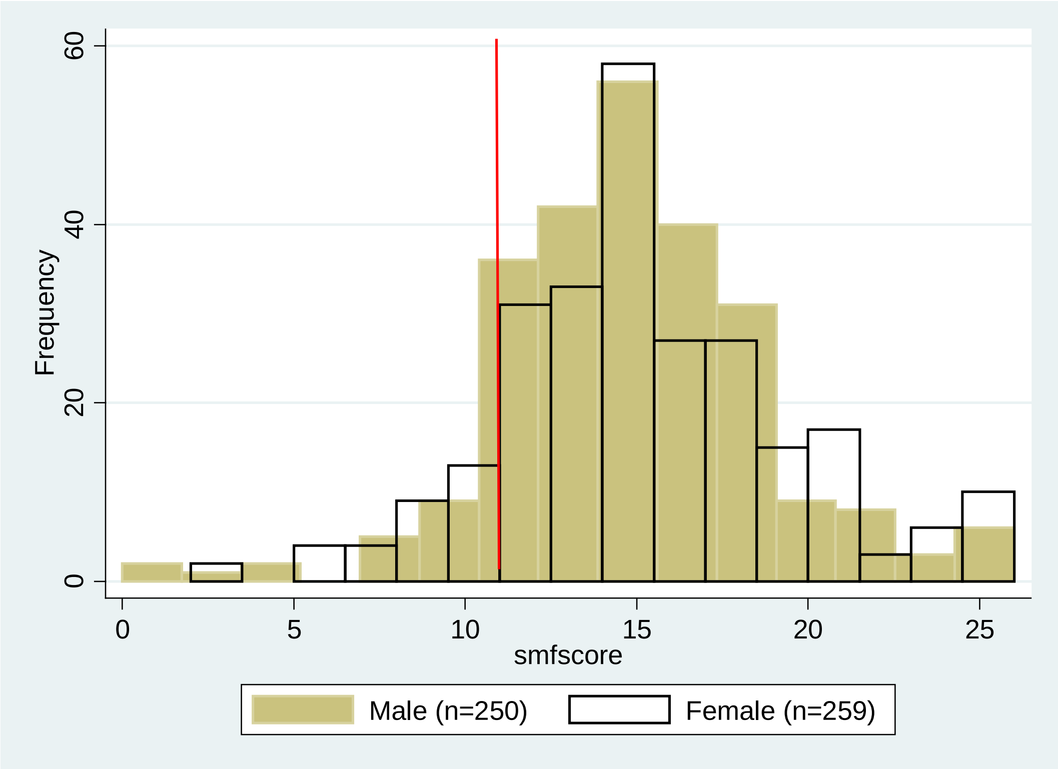
813 fetuses for 759 enrolled women
8 permanent drop-outs
38 dead
767 live born infants
3 permanent drop-outs
27 dead
142 missing anthropometrics
737 in follow-up at one-month-of-age
595 measured for anthropometry
15 permanent drop-outs
100 dead
67 missing anthropometrics
622 in follow-up at 24-months-of-age
555 measured for anthropometry
32 permanent drop-outs
52 dead
16 missing anthropometrics
538 in follow-up at 15-years-of-age
522 measured for anthropometry
166 missing values in anthropometrics, outcome variables or covariates
372 children included in the study

Figure 2.



The proportion (%) of participants with SMQF score at or above cut-off
0
20
40
60
80
100
0
5
10
15
20
25
SMFQ score cut-off

Figure 3.



Frequency
0
20
40
60
0
5
10
15
20
25
smfscore
Male (n=250)
Female (n=259)