Family Dynamism over the Life Course and Nutritional Status of Adolescents in Urban South Africa

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Abstract

Despite its status as the wealthiest country in sub-Saharan Africa, poor nutrition has long been a public health problem in South Africa, particularly for the Black African population. Recently, the attention has shifted to the increasing prevalence of obesity, particularly among Black girls and women. Moreover, the country is facing the nutritional double burden in which increasing obesity exists alongside stubbornly high rates of stunting. Whereas research has identified some well-known correlates of poor nutrition – access to food and lifestyle – no research to date has examined the relationship between family dynamism over the life course and nutritional outcomes. Using longitudinal data from the Birth to Twenty + Cohort Study in the Johannesburg-Soweto area, this analysis examines the role of cumulative transitions in maternal union status and fathers' provision of support on the odds of being overweight/obese (OV/OB) and underweight at age 15 for a sample of 1557 adolescents. We find that the effects of these transitions are only evident for overweight/obese. Specifically, we find that transitions in maternal union status has no effect on OV/OB but maternal union status at age 15 has a positive effect. We also find that girls who experience two or more transitions in fathers' support provision have significantly higher odds of being overweight/obese versus those who experience no transitions compared to boys. We also find that adolescents with high body esteem face lower odds of being OV/OB. Taken together, these findings point to the need to account for family circumstances over the life course and the interaction of gender in understanding nutritional outcomes.

Despite its status as the wealthiest country in sub-Saharan Africa, poor nutrition has long been a public health problem in South Africa, particularly for the Black African population. Recently, the attention has shifted to the increasing prevalence of obesity, particularly among Black women, a trend that is also seen in other countries with extreme social inequality (see Figure 1). A recent article ranked South Africa among the top three most obese nations in the world along with the US and Mexico (*Lancet* 2014). To add urgency to the issue, there have been increasing calls within South Africa to address the "epidemic of obesity which in the words of Dinky Levitt from the Chronic Diseases Initiative at the University of Cape Town is "here and now and unless we do something dramatic it's just going to become even worse." However, obesity is not the only challenge. Facing what has been termed the "double burden" of both over and under nutrition, South Africa, similar to other countries, has to address deep social inequalities that have been long present, which, in turn, has led to bifurcated nutrition outcomes (Norris et al. 2007; Kimani-Murage et al 2011). As a result, rates of stunting remain stubbornly high alongside increasing obesity. Whereas South African research has focused on the well-known correlates of diet and lifestyle (Feeley et al. 2011), it has paid far less attention to family structure. In this analysis, we draw on data from the Birth to Twenty + cohort study in the greater Johannesburg metropolitan area to examine the relationship between dynamism in family structure over the life course of Black African adolescents and their nutritional status at age 15.

This analysis takes inspiration from a recent article on familial instability over the life course and obesity in the U.S. (Hernandez et al. 2014). The authors of the study find that cumulative transitions in mother's union status is associated with a higher likelihood of being obese for girls but not for boys. Pathways of effects can be direct as in stress related changes in metabolic and consumption patterns or indirect through changes in access to financial and food resources. Our analysis extends the Hernandez et al. piece in two important ways: 1) modeling underweight and overweight/obesity to account for the bifurcation that marks the South African context and 2) testing one additional marker of family dynamism along with maternal union status. Specifically, we examine the influence of cumulative transitions in maternal union status and father support transition on nutritional status at age 15. In addition, we test for interaction effects with sex of youth given the higher rates of overweight found among females in South Africa (Puone et al 2002). We also undertake a number of sensitivity analyses to determine whether curvilinear effects exist and whether the directionality of transition and type of stability matter.

The importance of this analysis can be appreciated in a number of ways. First, the research on the social determinants of nutrition is still in early stages in South Africa yet malnutrition (both under and over) has attained crisis levels. Second, it has been well established that nutritional status in childhood and adolescence has effects throughout the life course. In particular, overweight/obese in the early life course is associated with diabetes in later adult life. Therefore, it is imperative that we develop a better understanding of the issue. Findings from this study will improve our understanding of family factors and nutrition and also contribute to the development of effective policies to ensure a health transition to adulthood in South Africa and elsewhere. Finally, most studies on the effects of family dynamism on children's well-being have been done in the US or other western contexts leaving us with little evidence about what these processes entail in other contexts. Moreover, most research on family instability over the life course has focused on children's sexual behavior and educational outcomes. The effects of family instability on nutrition has received comparatively, less attention, in the US and even less so in South Africa despite the fact that both countries are in the midst of an obesity epidemic. This is critical if we are to develop useful a framework to understand familial context and child outcomes in a comparative perspective.

Background

Perhaps the single most notable characteristic of South Africa is its claim to being one of the most unequal societies in the world (World Bank 2014). Driven by an apartheid legacy that institutionalized race-based divisions and sustained currently by high unemployment rates hovering around 36% for the African population and 22% for the Coloured community (Stats SA 2013), the majority of the population has yet to realize the promised gains from the collapse of apartheid 20 years ago. Nowhere is this better appreciated than in the he health transition underway in South Africa which defies the classic epidemiological transition model of shifting from a low life expectancy/infectious disease environment evident in many developing countries to a high life expectancy/non communicable disease regime seen in developed country contexts (Omran 1971). Instead what exists is a bifurcated model bearing characteristics of both developing and developed country scenarios. South Africa is not unique in this respect with other emerging economies, e.g. India, China, Brazil, and Mexico facing similar challenges. However, what is perhaps striking about South Africa is the pace with which these patterns have come about.

The nutrition transition is a critical component of this larger health transition. Recent work on nutritional trends in sub-Saharan Africa (Norris et al. 2007) highlights the fact that stunting remains a serious problem, despite improvements in GNP in many African countries, along with a recent dramatic increase in obesity particularly for girls. While acute food insecurity is not as prevalent in South Africa as it is in other parts of Africa, the double burden of malnutrition (Norris 2007) is clearly evident both in terms of quantity and quality of food intake. It is perhaps, not surprising, that there has been a temporal shift in diet between 1940 and 1992 with increasingly higher intake of fat that some have partly attributed to urbanization (Bourne et al. 2002). A sedentary lifestyle, access to highly processed foods coupled with increased incomes to facilitate access to such food is often characteristic of urban living (Dixon et al. 2007). The research in South Africa consistently points to gender differences in nutritional outcomes. Puoane et al. (2002) used DHS data to establish the anthropometric profile of RSA adult population (> 15 years of age). They showed that Black African women are particularly prominent in the overweight/obese category but that their perceptions of body size are not consistent with the objective measures. This national pattern appears to be replicated in regional level studies. For example, Kimani-Murage et al (2011) found that Black African girls (ages 10-20) are most prone to overweight/obesity and also have a positive relationship between SES and OV/OB in a rural population in the northeast of the country. They also found that girls with older mothers were prone to obesity possibly explained by lack of knowledge about healthy eating and cultural norms that valorize large body size. Van Niekerk et al (2014) found a similar result in a study focused on select populations in Western Cape province as did Tathiah et al. (2013) working in select communities of KwaZulu Natal thought they also found high rates of undernutrition amongst girls. The only study that does not show the female (dis)advantage is by Feeley et al. (2012). Using the same data as is used in this paper, they examined the relationship of diet, socioeconomic status and life style on body mass index (BMI) and fat mass and found that great soft drink consumption associated with higher BMI among boys only.

Taken together, this scholarship shows that poor nutrition and, in particular, over nutrition is a growing problem in South Africa particularly among Black African girls and women. However, no study that we are aware of has examined family dynamism over the life course and nutritional outcomes. This is a particularly notable gap in the South African context because of the well documented history of family disruption as a result of apartheid and ongoing challenges to family stability. Labor migration of Black men from the rural areas to the mines had profound consequences for families by separating men from their wives and children (Murray 1981). Other contributory factors to family complexity include low marriage rates for women and high rates of nonmarital childbearing (Madhavan, Harrison & Sennott 2013). The growing body of literature on fathers highlights the challenges that African men face to be responsible fathers which includes financial provision (Wilson 2006) and the prevalence of "absent fathers" (Posel & Devey 2006). However, more recent work has highlighted the contributions of non-resident fathers (Clark, Cotton & Marteleto 2015; Madhavan 2008; Madhavan et al. 2014). Young people growing up in South Africa, most born after the collapse of apartheid, are spared the most direct assaults of the apartheid system and are able to take advantage of better educational opportunities. However, the complexity of family arrangements that they are exposed to presents a number of challenges that have implications for their well-being. For example, a large literature exists on the social correlates of HIV infection (Harrison et al. 2006; Pettifor et al. 2005); early childbearing and educational progress (Grant & Hallman 2008; Madhavan & Thomas 2005; Marteleto et al. 2008). The influence of family context on nutritional outcome, on the other hand, has received scant attention. This is what we address in this analysis.

<u>Conceptual Framework</u>

Families play a critical role in determining the nutritional status of children and adolescents because they are the primary channel for food, financial resources to access food and guidance on health behaviors which, combined, have an impact on nutritional status. However, families are not static entities particularly in low income communities as described in the previous section. Therefore, it is critical that we better understand the pathways through which transitions in family structure and functioning influence the nutritional status of young people.

Most transitions that occur over the life course usually trigger a number of other changes that have short term and longer term effects. Moreover these effects may be gendered. A large amount of scholarship has shown a negative effect of family instability on child outcomes in the US (Fomby and Cherlin 2007; Hofferth 2006; Magnuson & Berger 2009) though differential effects by gender are equivocal and depend on outcome. A recent study by the American Psychological Association suggests that females may be more sensitive because girls put more emphasis on positive relationships (APA 2012). Research on family instability in South Africa and Africa, more generally, is still at an early stage but recent work points to negative effects. Goldberg (2013a) shows that family instability in childhood is associated with adolescent childbearing and early school drop-out in urban South Africa and initiation of sex in Kenya (2013b). Clark and Hamplova (2013), in a comparative study of 5 African countries, show that children of single mothers face higher mortality risks compared to children of mothers in union.

Some researchers have focused on stress to explain outcomes for children. The basic idea behind the stress model is that all transitions that occur over the life course – positive or negative – entail some amount of stress on individuals and systems which can play out in physical and emotional outcomes (Epel et al. 2002; Turner & Scheiman 2008). While some may be short lived, other effects are likely to last well into the life course. Indeed very recent research has linked exposure to high stress in childhood with chronic disease in later life (Winning et al. 2015). Change in maternal union status which, regardless of entry or exit from a union, introduces stress into family systems (Teachman 2003; Wu & Martinson 1993). The disruption of paternal linkages, and the formation of new relationships with mothers' partners and half siblings increases the amount of stress and may affect girls and boys differently. Looking specifically at nutritional outcomes for children, Schmeer (2012) showed that children who experienced a union dissolution were more likely to become overweight or obese (OV/OB) compared to children who did not. Hernandez et al.'s (2014) followed up on Schmeer's work by using stress theory to examine the cumulative effect of marital instability on nutritional status of young adults. They found that a greater number of transitions increases the likelihood of being OV/OB but only for girls. Stress theory would explain this finding as a result of changes in eating behavior through disruption of routines and/or parental vigilance, or alteration to metabolic processes (Cappucio et al. 2008; Yarcheski & Mahon 1999)). Moreover, the coping mechanism of increasing intake of high fat "comfort foods" appears to be gender specific (Latinen et al. 2002). This is particularly concerning given that eating habits established in early years are critical in establishing eating practices throughout the life course (Birch & Fisher 1998). The link between stress and underweight has received even less attention in the sociological literature partly because malnutrition is not a problem facing developed country contexts. Stenhammer et al. (2010) found that family stress is associated with both overweight and underweight among Swedish adolescents. While one might expect the link between stress from transitions and underweight to be stronger in poor, developing country contexts in which food shortages are common, we are not aware of any studies that have examined this relationship.

Stress is not the only mechanism through which transitions can impact children's outcomes. Maternal union disruptions are usually accompanied with changes in financial resources. In fact, it is this factor that has been seen as the critical pathway through which children of single mothers in the US context experience unfavorable outcomes in physical and emotional health and educational progress (Thomson et al. 1994). However, a maternal union disruption with the biological father does not necessarily terminate financial provision by the father either in the US or in South Africa (Madhavan et al. 2014). Moreover, even if the mother enters a new union, biological fathers continue to play an important role in providing financial and material support to their children particularly if the new partner has his own children (Madhavan et al. 2014). Therefore, changes in the provision of financial support by biological fathers can have effects independent of cumulative transitions in maternal union status. Children who experience a lot of volatility in father support provision may be more prone to being underweight because of financial uncertainty and difficulty accessing food, whereas, stable access to paternal financial support may increase the likelihood of overweight/obesity. Alternatively, it can also act as a proxy for closeness to the biological father which, in turn, could have a different set of effects from maternal union status. For example, children who have a regular, close relationship with fathers may be less likely to be OV/OB because of better vigilance over eating behaviors. Furthermore, these effects may be gendered as has been shown in other research (Lundberg et al. 2007). Therefore, including a separate measure for support provision by father, as we do in this analysis, allows us to identify effects of paternal linkages that may be independent of changes in maternal union status.

Body esteem, defined as one's self-evaluation about his/her body, is likely to be a key determinant of nutritional status and also play a mediating role in the relationship between transitions and nutritional status. It is often closely correlated with self-esteem though the two measure different dimensions and can vary across culture (Franzoi & Shields 1984; Henrique and Calhoun 1999). Those with high body esteem may be less likely to be overweight/obese whereas those with low body esteem may face greater risks of being both overweight and underweight as a result of reactive eating behaviors (Furnham et al. 2002). Moreover, those with high body esteem maybe able to weather the turbulence of transitions without any significant changes to eating behavior than their peers with low levels of body esteem.

Data and Methods

We draw on data from the Birth to Twenty (Bt20) + cohort study in the greater Johannesburg-Soweto municipality that began in 1990. Soweto, the largest township in South Africa has both economic and housing heterogeneity and is almost entirely made up of Black Africans. Fast food establishments are ubiquitous though there has been a recent increase in access to “nutritious” food outlets. Whereas gyms are available to wealthier residents, the vast majority have very limited facilities for physical exercise. Soweto is also home to the largest teaching hospital in the southern hemisphere and an extensive network of clinics.

Bt20 was initiated as an observational, ecological study of human development, health and well-being, from before birth and has continued into young adulthood (Bt20). Prospective data collection began in the ante-natal period and continued with yearly and some twice-yearly follow ups until age 20. Data collection has covered a broad range of topics including, amongst others, anthropometric measures, nutrition, family composition, socio-economic circumstances, childcare, cognitive development, and social experiences at home, school, and in the community. Children born between April and June 1990 and resident for at least 6 months in the Soweto-Johannesburg municipality were enrolled into the study (n=3273). The cohort includes Black, White, Indian and Colored children but we limit this analysis to only the Black children who comprise the largest proportion of the cohort. Attrition in the study was about 30% bringing the final analytic sample to 1557. However, missing data for the marital status models results in an N of 1210.

Expanding on the Hernandez analysis which uses only one measure of family structural dynamism – mother’s union status over the life course -, we examine two: mother’s union status and father’s provision of financial support – to model the influence of cumulative family transitions over the life course on nutritional status at age 15. Each measure is a cumulative count of the number of transitions over the life course. For example, every time the mother changes union status, the index increases by 1. Similarly, every time there is a change in support provision by father, the index increases by 1. We use multinomial logit models to predict the likelihood of being overweight/obese – OV/OB (+1 Z-score) or underweight (-2 Z-score) at age 15. We conducted both linear risk modeling given the evidence that cumulative changes matter for outcomes (Fomby and Cherlin 2007) and threshold risk models to test whether effects are only evident after a certain number of transitions have been reached (Greenberg et al. 2001, Jones et al. 2002). We found no linear effects of either maternal union transitions or father's provision of support transitions. Therefore we only show results from the threshold risk models. Control variables include sex of adolescent, birthweight, number of siblings, household structure at age 15, household wealth level, maternal age at birth, maternal education, maternal union status at birth and age 15, paternal age at birth, paternal education and percentage of adolescent life father and mother alive. All models pool sex of adolescent to ensure sample size but test for interaction effects of sex and cumulative transitions. We also test for the mediating effects of body esteem and interaction of sex and body esteem. Sensitivity analyses to determine the existence of curvilinear effects and to assess directionality of transitions and type of stability effects are also conducted.

Results

Table 1 presents descriptives of the sample stratified by sex.

Insert Table 1 here.

As expected, girls have a higher BMI than boys and a greater proportion are found in the overweight category. However, a little more than 25% of the total sample are classified as underweight with boys dominating this category. Underscoring what we know about family dynamism in South Africa, a large proportion of boys and girls experience transitions in maternal union status and fathers' provision of support over the life course.

Table 2 shows results from multinomial logit models examining the relationship between cumulative maternal union status transitions modeled as linear risk and nutritional status. In the interest of space, we only show the results for OV/OB because we found no main or interaction effects of transitions on the likelihood of being underweight. Model 1 is the basic model with only number of maternal union transitions; model II introduces body esteem and model III includes interaction effects of sex of youth and transitions. The reference category is normal BMI.

Insert Table 2 here.

There is no effect of either category of maternal union transitions on the likelihood of being OV/OB nor is there an interaction effect of sex and transitions (model III). However, there is a positive effect of maternal union status at age 15. Children whose mothers are in union face 70% higher risk of being OV/OB than their peers whose mothers are not in union. The other significant effect is body esteem -

high levels of body esteem decreases the likelihood of being OV/OB by about 6%. The independent effect of sex of adolescent is very strong in all models with girls facing much higher odds of being overweight/obese compared to boys We ran models (not shown) that tested for interaction effects of sex of adolescent and body esteem and found no effect.

When we examined our second indicator of interest – transitions in father support provision – we again found no effect of transitions on the likelihood of being underweight. Therefore, we only show the results for OV/OB in Table 3 following the same sequence of models as in Table 2.

Insert Table 3 here.

The independent effect of father support transitions is only evident in Model III with the inclusion of the interaction effect of sex and transitions which is also significant. Adolescents who experience two or more transitions in father support provision are 52% less likely to be OV/OB. However, when interacted with sex, we find that the effect of being exposed to 2+ transitions in father support provision vs. no transitions is 2.3 times greater for girls compared to boys. This suggests that girls cope with this type of dynamism by altering their eating behavior in such a way that compromises their nutritional heath as shown below in Figure 1.

Insert Figure 1 here.

In addition, we find that high body esteem lowers the likelihood of being OV/OB but there is no interaction effect (not shown) with sex of adolescent. All the control variables behave in the same way as the maternal union status transition models. In order to better understand the underlying mechanisms that might be at work to explain these outcome, we performed three types of sensitivity analyses discussed below.

Sensitivity Analysis

First, we ran the linear risk models including a squared term for the cumulative number of transitions (results not shown). This yielded no change to the results for either maternal union transitions or father support provision suggesting that there is no curvilinear effect in play. Second, we disaggregated the reference category, "zero transitions," into "always in the state" and "never in the state" to determine whether the effects of dynamism is dependent on the *type* of stability. Third, we tested whether directionality of transition matters by disaggregating each transitions indicator into "positive" - transitioning *into the state* - and "negative" - transitioning *out of the state*. Each measure is a continuous indicator of the cumulative number of that type of transition. Table 4 shows results of these two sensitivity tests for both marital union status and father's support provision.

Insert Table 4 here.

There are no effects of disaggregating zero transitions in maternal union status or father support for either underweight or OV/OB. When we examined directionality, we found no effects of directionality of transitions for maternal union status for either being OV/OB or underweight. However, there is a significant effect of positive transitions in father's support provision. The higher the number of transitions to receiving support from fathers, the odds of being OV/OB decreases by 38%. Taken together this result underscores the importance of financial resources in enabling adolescents to maintain nutritional health.

Discussion

We set out in this analysis to better understand the complex pathways through which family dynamism over the life course can impact the nutritional status of adolescents in an urban context in South Africa. Using the transitions literature for conceptual guidance, we examined the relationship between transitions in maternal union status and fathers' provision of support over the life course and the likelihood of being overweight/obesity and underweight for 15 year olds. Furthermore, we also investigated the mediating effects of body esteem and the extent to which effects are gendered. Our results point to a set of nuanced effects that are only apparent for predicting overweight /obesity and more pronounced for girls. We found no effects of maternal union transitions on OV/OB but we did find that adolescents with mothers in union at age 15 experience elevated risks of being OV/OB. When we examined the influence of transitions in fathers' support provision, we found that being exposed to two or more transitions significantly lowers the odds of OV/OB. However, the interaction effect with sex of adolescent shows that girls who experience 2+ transitions face higher odds of being OV/OB. High body esteem consistently lowers the odds of being OV/OB in all models but has no differential effect by sex. Finally, sensitivity analysis confirmed that effects are not sensitive to the type of zero transition but may be influenced by directionality of transitions. The greater the number of transitions *into* receiving paternal support protects all children from OV/OB but no effect is notable for transitioning *out of* receiving support. .

Taken together, these results suggest that over nutrition is sensitive to family dynamism but that girls, in particular, are at risk. This provides qualified support for stress theory in that the cumulative effects of change in family structure and financial connection to fathers appears to alter eating behaviors – perhaps an increase in consumption of high fat "comfort" foods – or changes in physical activity which, in turn, increases risk of OV/OB for 15 year old girls. The fact that the results are stronger for transition in father support provision than for maternal union status suggests that connection to fathers entails independent pathways through which stress processes operate that are different from exposure to maternal union status changes. It also underscores the direct effect of financial support in determining nutrition which may operate independently of stress induced changes. Additionally, the sensitivity results add further nuance to the process s explanation by highlighting the need to think about type of change in family structure and functioning. Positive changes appear to be beneficial in enabling young people – regardless of sex – to maintain normal BMI. This can be a direct result of financial resources that is critical in accessing healthy food and promoting health seeking behaviors but also an indirect effect of having more contact with fathers.

In assessing these findings, it is important to consider the limitations of the study. While large for a longitudinal cohort study, the sample size is likely too small to detect significant differences. Therefore, we suspect our findings provide conservative estimates of effects that should be confirmed in future research with larger sample sizes. Moreover, we suspect that the absence of any effects on underweight might be an artifact of insufficient sample sizes. Second, because the data are based on one urban area in South Africa with unique characteristics, these findings have limited generalizability. However, given the ubiquity of family structural dynamism in most Black African communities in South Africa, we would expect to find similar findings from other regions as well as nationally. Fortunately, there are a number of excellent longitudinal datasets available in South Africa including Health and Demographic Surveillance System (HDSS) data from Agincourt in Mpumalanga and Hlabisa in KwaZulu Natal, and the Cape Area Panel Study (CAPS) which could be used to replicate this analysis. Finally, more sophisticated analysis using an event history approach could be attempted which would establish lines of causality with far greater precision than the current analysis.

In conclusion, this analysis has made an important contribution to the growing scholarship on the social determinants of nutritional status. It is particularly timely for South Africa and other contexts that are in the midst of nutrition transitions that are challenging conventional predictions and bringing about urgent concerns about stemming the tide of obesity. The analysis presented in the paper has shown the importance of considering the family environment in a life course perspective, in particular, paying close attention to how transition over time manifests in biological outcomes. Moreover, it has confirmed other studies from South Africa that girls face elevated risks of obesity which is made all the more pronounced when they are coping with family flux. More research is needed to identify critical points of intervention to mitigate the negative effects of such transitions for all young people in South Africa and elsewhere.

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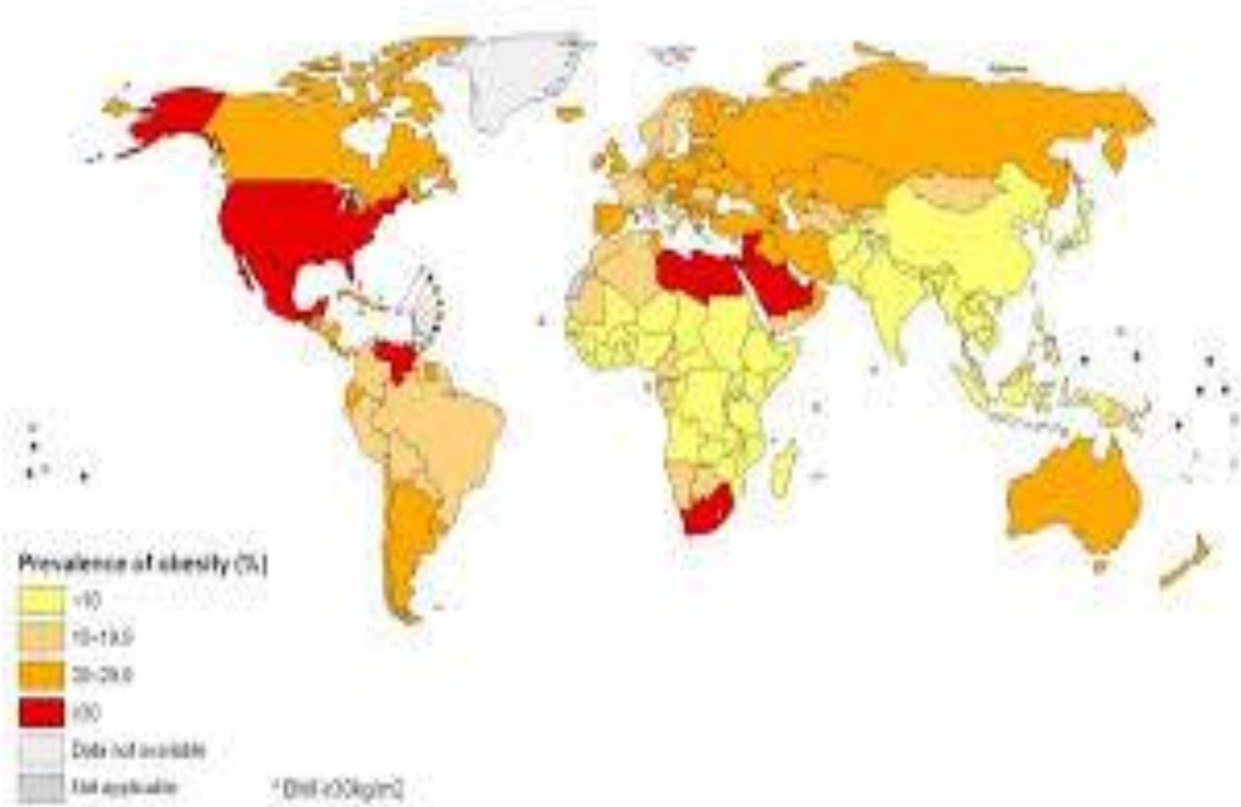
Figure 1: Global Prevalence of Obesity



Source: World Health Organization (2008)

Table 1: Descriptive Characteristics of Analytic Sample Stratified by Sex of Adolescent, Birth to Twenty+ (means & percentages)

	Boys	Girls	Total
BMI*			
Mean	19.6	22.2	20.9
Underweight	37.6	16.1	26.6
Normal	47.7	53.5	50.7
Overweight/Obese	8.5	25.3	17.1
Missing	6.2	5.1	5.7
Maternal Union Status Transitions			
Mean	.73	.67	.70
0	46.3	50.2	48.3
1	36.5	36.4	36.4
2+	17.1	13.4	15.2
Father Support Provision Transitions			
Mean	1.02	1.11	1.07
0	58.4	56.8	57.5
1	14.8	15.8	15.3
2	11.6	11.1	11.4
3+	15.2	16.4	15.8
Adolescent Characteristics			
Low birthweight**	9.4	8.4	8.9
Body Esteem (mean)$^{+}$	67.7 (14-84)	65.1 (11-84)	66.4
Number of siblings at year 14 (mean)	1.96	1.91	1.94
Household Structure (age 14)			
Nuclear	39.1%	38.9%	39.0%
Extended	56.7%	56.0%	56.3%
Mother Characteristics			
Maternal Age (Mean)	25.9	25.6	25.8
Maternal Education (1990)			
No Schooling	0.5%	1.1%	0.8%
Some Primary	5.2%	5.5%	5.3%
Completed Primary	6.9%	6.5%	6.7%
Some Secondary	44.3%	39.5%	41.8%
Completed Matric	29.1%	34.5%	31.9%
Post School	7.0%	6.8%	6.9%
Missing	7.1%	6.1%	6.6%
Maternal Marital Status at Birth			
Not married/not cohabiting	63.4%	68.8%	66.2%
Married/cohabiting	36.3%	31.0%	33.6%
Maternal Marital Status at Age 15			

Not married/not cohabiting	44.1%	45.5%	44.8%
Married/cohabiting	55.9%	54.5%	55.2%
Father Characteristics			
Father's age at birth of child (mean)	31.9	31.5	31.7
Paternal Education (1990)			
No Schooling	0.1%	0.5%	0.3%
Some Primary	2.1%	1.9%	2.0%
Completed Primary	3.7%	4.6%	4.2%
Some Secondary	23.0%	20.5%	21.7%
Completed Matric	30.6%	29.5%	30.1%
Post School	10.3%	12.9%	11.6%
Missing	30.1%	30.1%	30.1%
Percentage of life father alive (mean)	92.3%	93.8%	93.1%
Household Wealth Index (1990)			
1	15.9%	14.2%	15.0%
2	17.3%	17.5%	17.4%
3	31.2%	32.5%	31.9%
4	19.9%	17.6%	18.8%
5	8.3%	10.4%	9.4%
Missing	7.4%	7.8%	7.6%
Total	757	800	1557

*Categories for determining BMI status are based on the WHO growth curves for adolescents

** Low birthweight is identified as being <=2Z below mean which is consistent with the WHO definition of being <=2500 grams

[+] Body esteem is calculated as follows: sum of 21 items scored on a Likert Scale (0-5 with 5 being most positive); there are 50 cases where none of the items were recorded (missing) – therefore we imputed the body esteem index with the mean.

Table 2: Transitions in maternal union status and overweight/obese at age 15

	Model I	Model II	Model III
Maternal Union Transitions			
No transitions	Ref	Ref	Ref
One transitions	1,09 (.190)	1.12 (.198)	1.07 (.353)
Two+ transitions	1.24 (.260)	1.23 (.270)	.984 (.447)
Adolescent Characteristics			
Sex (ref: male)	2.88 (.183)***	2.59 (.188)***	2.35 (.277)***
# of siblings	.912 (.066)	.886 (.069)	.885 (.069)
Low Birthweight	.664 (.342)	.618 (.358)	.620(.358)
Body Esteem at age 15	N/A	.957 (.006)***	.957 (.006)***
Maternal Characteristics			
Age of mother at birth	1.02 (.015)	1.02 (.016)	1.02 (.016)
Educ. level of mother at birth	1.09 (.176)	1.07 (.186)	1.07 (.186)
Union status at birth			
Not in union	Ref	Ref	Ref
In union	.808 (.197)	..922 (.207)	.915 (.208)
Union status at age 15			
Not in union	Ref	Ref	Ref
In union	1.68 (.201)**	1.66 (.208)**	1.66 (.208)**
Paternal Characteristics			
% of life father alive	.864 (.005)	.996 (.005)	.996 (.005)
Educ. level of father at birth	1.03 (.174)	1.14 (.182)	1.14 (.183)
Household Characteristics			
Household structure at age 15			
Extended	Ref	Ref	Ref
Nuclear	1.04 (.175)	1.10 (.182)	1.09 (.183)
Wealth Rank of HH at birth	1.04 (.074)	1.03 (.078)	1.03 (.078)
Sex of adolescent x Number of Union Transitions (Female)			
None * Female	N/A	N/A	Ref
One * Female	N/A	N/A	1.09 (.413)
Two+ * Female	N/A	N/A	1.47 (.541)
R2 (Nagelkerke)	.135	.205	.207
N	1127	1127	1127

*.05 level **.01 level ***.001 level

Table 3: Transitions in father support provision and overweight/obese at age 15

	Model I	Model II	Model III
Number of Father Support Transitions			
None	Ref	Ref	Ref
One	.940 (.256)	.955 (.221)	.974 (.398)
Two or more	.910 (.214)	.900 (.181)	.486 (.368)*
Adolescent Characteristics			
Sex (ref: male)	2.68 (.163)***	2.47 (.167)***	2.05 (.213)***
# of siblings	.970 (.058)	.942 (.059)	.941 (.059)
Low Birthweight	.837 (.275)	.827 (.284)	.821 (.284)
Body Esteem at age 15	N/A	.959 (.005)***	.958 (.005)***
Maternal Characteristics			
Age of mother at birth	1.01 (.014)	1.01 (.014)	1.01 (.014)
Educ. level of mother at birth	.980 (.159)	.942 (.166)	.954 (.166)
Union status at birth			
Not in union	Ref	Ref	Ref
In union	1.05 (.177)	1.02 (.185)	1.01 (.185)
% of life mother alive	1.00 (.007)	1.00 (.008)	1.00 (.008)
Paternal Characteristics			
% of life father alive	1.00 (.004)	.998 (.004)	.998 (.004)
Educ. level of father at birth	.833 (.154)	.861 (.160)	.867 (.160)
Household Characteristics			
Household structure at age 15			
Extended	Ref	Ref	Ref
Nuclear	1.27 (.156)	1.33 (.162)	1.33 (.162)
Wealth Rank of HH at birth	1.03 (.068)	1.02 (.069)	1.02 (.069)
Sex of adolescent x Number of Father Support Transitions (Female)			
None * Female	N/A	N/A	Ref
One * Female	N/A	N/A	.972 (.477)
Two+ * Female	N/A	N/A	2.27 (.422)*
R2 (Nagelkerke)	.126	.188	.192
N	1452	1452	1452

*.05 level **.01 level ***.001 level

Figure 1: Predicted Probabilities of Being OV/OB by Number of Support Transitions

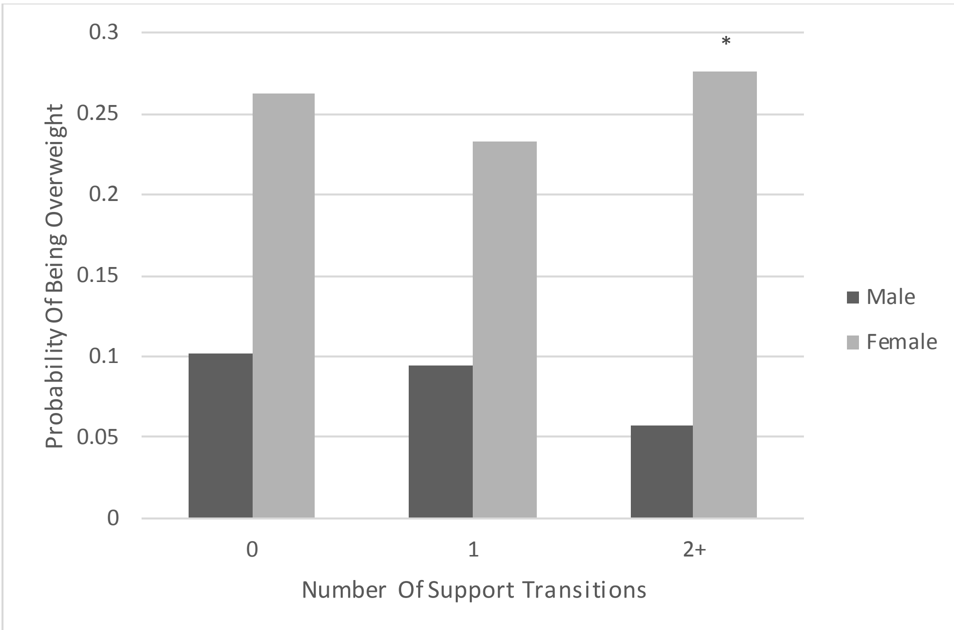


Table 4: Results of sensitivity analyses

Disaggregating Zero Transitions				
	Maternal Union Status		Father's Provision of Support	
	OV/OB vs normal	Underweight vs. normal	OV/OB vs normal	Underweight vs. normal
Zero Transitions – Never Support	Ref	Ref	Ref	Ref
Zero Transitions – Always Support	.909 (,609)	.689 (.363)	2.97 (,566)	1.35 (.268)
One Transition	.993 (.557)	.567 (.289)	2.52 (.638)	1.57 (,315)
Two+ Transitions	.961 (.615)	.567 (.330)	1.26 (.620)	1.188 (.280)
R^2 (Nagelkerke)	.216	.206	.199	.199
N	1127	1127	1452	1127
Directionality of Transitions+				
	Maternal Union Status		Father's Provision of Support	
	OV/OB vs normal	Underweight vs. normal	OV/OB vs normal	Underweight vs. normal
Number of Positive Transitions	1.26 (.175)	.912 (.155)	.624 (.228)*	.872 (.080)
Number of Negative Transitions	1.13 (.197)	.843 (.163)	.783 (.184)	.989 (.094)
R^2 (Nagelkerke)	.205	.205	.191	.187
N	1127	1127	1452	1127

*.05 level **.01 level ***.001 level

+ These results are from separate models that include each type of directionality; all models include all controls and interaction terms