Adolescent overweight has become a major public health issue in the U.S. The percentage of overweight adolescents ages 12 to 19 more than tripled between the 1960s and 2002 (NCHS 2005). Most research on the consequences of adolescent overweight focuses mainly on physical and psychological well-being and some on social adjustments. Amidst all these studies, a relatively under-explored area is the sexual experiences of overweight adolescents. In addition to overweight teens, this study also investigated the development of underweight youth. This study aimed to utilize the U.S. National Longitudinal Study of Adolescent Health (Add Health) data to examine the sexual development of youth by weight status from adolescence to young adulthood.

Background

A good starting point to unravel the process of sexuality development is to examine how weight status affects the timing of transition to first sexual intercourse during adolescence. Studies that examine sexual activity among overweight adolescents usually look at general sexual behaviors (e.g., odds of having sex between time points), rather than the transition to first sex (an exception is the study by Cawley, Joyner & Sobal, 2006). Prior studies have shown that overweight adolescents or college students are significantly less likely to be in a romantic relationship or to have sex (Chen and Brown 2005; Halpern *et al.* 1999; Wiederman and Hurst 1998). Although Cawley and colleagues looked at body weight and sex debut, they did not seek to study the more proximal determinants of first sexual experience, such as embeddedness in peer networks and experience of romantic relationships. Researchers know that overweight is associated with lower likelihood of having sex, yet little is known about whether being overweight is linked to significantly later timing of first sex at the population level. Furthermore, little is known about why overweight delays initiation of first coitus. In other words, the mechanisms related to overweight and sex debut are not understood well enough.

Researchers studying the consequences of adolescent overweight know equally little about the development of sexuality from adolescence to young adulthood. Part of the reason for this dearth of knowledge about adolescent sexual development is the limitations of measurements of sexual experience. In most studies, sexual experience is measured at one time point. Given that adolescence is a transitional phase from childhood to adulthood, in which a great amount of physical change and identity exploration take place, sexual activities can vary over time. As adolescents made the transition to first sex, how does their developmental trajectory of sexual relationships evolve? Are these different trajectories affected by the weight status of teenagers? In turn, the best way to study the developmental trajectories of adolescents is to track sexual experiences over several years, so that a more complete picture can be seen.

This study seeks to address four major research questions: (1) What are the associations between different weight statuses and the timing of first sex in adolescence? (2) What are the underlying mechanisms that explain the relationship between body weight and sex debut? (3) Are the processes through which weight status influences age at first sex different during younger and older ages in adolescence? (4) How does sexuality develop across the entire span of adolescence and early adulthood for adolescents of different weight statuses?

Research Design

Data.   The data used for the current study come from the National Longitudinal Study of Adolescent Health (Add Health). Add Health was designed to study health behaviors of a cohort of adolescents in grades 7-12 during the 1994-1995 academic year. Follow up surveys were conducted in 1996 and between 2001 and 2002.

Study Sample.   The adolescents being studied are those who participated in all three waves of Add Health data collection and those who have valid longitudinal sample weights.[1] Adolescents who had their first sex before the Wave 2 interview (n=3,923, about 34%) were left-censored from the study. This decision was made because objective height and weight were not available in Wave 1. Although a prior study has shown that self-reported height and weight in Add Health are in general reliable for 96% of the adolescents (Goodman, Hinden, and Khandelwal 2000), a closer look at the Body Mass Index (BMI)[2] data showed under-reporting issues (i.e., reported BMI values are lower than measured BMI values) among the overweight and over-reporting issues among the underweight. Hence, measured BMI data in Wave 2 were used instead of the Wave 1 subjective reports. In turn, given that the key predictor, weight status, is taken from Wave 2, those who had made the transition to first sex prior to Wave 2 were censored from the analysis.[3] After all the selection criteria, the final sample is 6,905 adolescents between the ages of 12 and 21 in the academic year 1994-1995.

Variables and Measures.   Retrospective reports in Wave 3 for *age at first sexual intercourse* were used as the outcome variable. The construction of the *sexual relationship trajectory* involved two steps: creating age-specific counts of sexual relationships in a given year and extracting trajectories from these age-specific reports using a mixture modeling technique. Adolescents were asked to report the romantic relationships they were involved in for every wave of the Add Health data. In addition to the start and end date of each relationship, the date of the first sexual intercourse within each relationship was recorded. Thus, linking up all three waves of relationship data offers a near-complete history of sexual relationships for the majority of respondents, except for those who did not participate in certain waves of Add Health. After age-specific observations of sexual relationship were created for each respondent, group-based mixture modeling technique (Nagin 2005) was utilized to extract several distinct trajectories embedded in these data. *Weight statuses* are constructed by categorizing BMI values into underweight, normal weight, at risk of overweight, and overweight, based on the

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[1] There are a total of 11,621 respondents who were interviewed in all three waves. Of these adolescents, 793 did not have a valid longitudinal sampling weight and were excluded from this study.

[2] BMI is measured by converting height from inches to meters and weight from pounds to kilograms. BMI = [weight in kilograms (kg.) / height in meters squared (m^2)]. When "weight status" is mentioned hereafter, it refers to a composite measure that depicts both the height and weight of adolescents. Weight status will be used interchangeably with "body type" in this study.

[3] Left censoring at Wave 2 caused a large sample attrition of 3,923 respondents from the original panel data. Among these 3,923 adolescents, 2,637 had their first sexual experience prior to Wave 1 and 1,286 between Wave 1 and Wave 2. A comparison of respondents shows that those who are included in this study possess a less risky profile for early sex debut. The implications of this sample selection bias for the event history analyses will be further investigated. To ensure the findings are not significantly affected by the left censoring decision and the type of BMI used, comparisons were made between three models that utilize different types of BMI measures from both Wave 1 (self-reported BMI) and Wave 2 (self-reported and measured BMI). Results reveal that the effects and significance level of all predictors are quite similar across the three models, regardless of the type of BMI used to construct the weight status categories. The only major difference between models is the stronger negative influence of underweight on timing of first sex when subjective BMI values are used to construct weight statuses. These results show that the decision to start the study from Wave 2 and to use objective BMI to measure weight status do not influence the findings substantially (Tables for these tests available upon request).

age- and sex-adjusted standards published in the Centers for Disease Control growth chart.[4] A set of *sociodemographic variables* were constructed from the Wave 1 in-home questionnaire. These variables are age at Wave 1, gender, race, maternal education, family structure, and family income.

Based on prior research on adolescent sexual behaviors, a set of characteristics that are closely associated with initiation of first sex are also controlled in the models. These characteristics are mother-child closeness, positive family climate, self-reported grades, school adjustment, self-esteem, religiosity, respondent's attractiveness, motivation to have sex, and perceived social consequences of sex.

Missing Values and Complex Survey Design.   Missing data in the current study are handled using the multiple imputation procedure (Proc MI) in SAS. In the analyses that follow, both descriptive statistics and the output for various different kinds of regression models are the combined outputs from five imputed datasets using Rubin's rule (Rubin 2004). The complex survey design of the Add Health data is dealt with by using the SAS-callable SUDAAN program. Appropriate longitudinal sampling weights are applied to the statistical models. In addition, clustering and stratifying variables are both taken into account to adjust the standard errors.

Statistical Analyses

Discrete-time event history models were used to examine the effects of weight statuses and social relationship variables on the likelihood of transition to first sex. A person-year file was created for each year of observation between the age at Wave 2 and the age when the first sexual intercourse occurred. To investigate the different developmental meanings of weight status and first sex in two stages of adolescence, the person-year file was further separated into one file that contains exposure ages younger than 18 and another file with exposure ages at and above 18. These two datasets were used to run two sets of event history models that include the same predictors shown in the models using the pooled sample.

A group-based modeling technique was used to extract four developmental trajectories of sexual relationships from adolescence to young adulthood. After the sexual trajectories were identified, a four-group categorical outcome variable was created. Weight statuses and the entire array of variables used for predicting first sex are entered into a multinomial logistic regression to see how they predict membership in the various sexual relationship trajectories.

Preliminary Results

Results shown in Table 1 indicate that weight status indeed affects the timing of sex debut. In the baseline model, underweight and overweight adolescents are significantly less likely to initiate first sexual intercourse. Social relationships play an important role in explaining why weight status delays the transition to first sex. On the other hand, when developmental stages were taken into account, different processes emerged. The status of underweight only delays sex debut in the younger teen ages, not in the older teen ages. The lower likelihood of overweight teens to initiate first sex is explained by the social relationship variables in the

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[4] Adolescent underweight is defined as those whose BMI values fall at or below the 5th percentile of the age- and sex- specific BMI distribution. BMI values that fall between the 5th and 85th percentiles are defined as normal weight. At risk of overweight is defined as having a BMI value that is between the 85th and 95th percentiles. Finally, those who have a BMI value above the 95th percentile are categorized as being overweight.

younger ages, not in the older ages. These results indicate that the friendship context in adolescence fosters the formation of intimate dyadic relationships and sets the stage for sexual development. Overweight adolescents, in particular, are less integrated into the peer networks and are more likely to feel excluded, less likely to have close friendship ties, and less likely to experience romantic relationships. These are key proximal factors leading to later sexual debut in adolescence. Although delayed first sex may be beneficial for adolescents, it has different implications for youth when the association between weight and sex debut is understood in a social relationship context. Underweight and overweight adolescents have later onset of first sex not because they learn to delay gratification, but because they are lacking the opportunities to interact closely with peers and thus develop intimate relationships from such context.

The findings presented in Figure 1 demonstrate the various developmental trajectories of sexuality and the characteristics of these trajectories. Four distinct types of sexual trajectories are identified: a high-risk trajectory (involving multiple partners over time), a constant-one-partner trajectory, a progression-to-one-partner trajectory, and a never-had-sex trajectory. Results in Table 2 show the relationship between body weight and sexual relationship trajectories. Overweight adolescents are less likely to experience the high-risk, the constant-one-partner, and the progression-to-one-partner trajectories, relative to the never-had-sex trajectory. These negative associations are again explained by social relationship characteristics of an adolescent. The major implication of these findings is that a lack of practice in cultivating relationship skills with same-sex as well as opposite-sex peers can have profound influences on later development. Further problems in forming unions, such as cohabitation or marriage, can emerge later on because intimate relationship experiences in adolescence foster union formation in early adulthood (Crissey 2005; Meier and Allen 2007; Raley, Crissey, and Muller 2007).

Figure 1. Trajectories of sexual relationship from adolescence to young adulthood
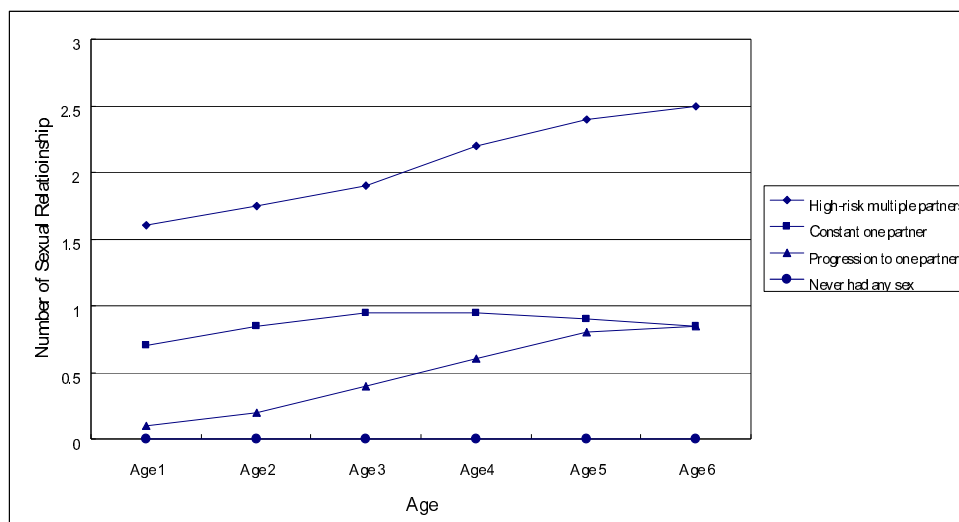
Table 1: Odds ratios of discrete-time event history models predicting transition to first sexual intercourse, Add Health data (weighted & multiply imputed data), N=6,905

| | Model 1 | Model 2 | Model 3 | Model 4 | Exposure Age | |
					age <= 17	age >= 18
Weight Statuses						
Underweight	0.75*	0.77*	0.77*	0.81	0.58*	1.08
Normal Weight (ref.)	---	---	---	---	---	---
At risk of overweight	0.98	0.94	0.96	1.01	1.11	0.98
Overweight	0.82**	0.78***	0.81**	0.89+	0.90	0.85*
Age (time-varying)	1.10***	1.11***	1.13***	1.15***	1.62***	0.81***
Male	0.98	0.98	0.76***	0.80***	0.79**	0.76**
Race						
White (ref.)		---	---	---	---	---
Black		1.16	1.09	1.28**	1.41***	1.16
Hispanics		0.89	0.82*	0.85*	0.85	0.87
Other		0.69***	0.70***	0.78*	0.67*	0.88
Maternal Education						
Less than High School (ref.)		---	---	---	---	---
High School		1.03	1.04	0.99	0.90	1.08
Some College		0.96	0.99	0.90	0.78*	1.03
College and beyond		0.79**	0.86+	0.77**	0.70**	0.82+
Family Structure						
Two-biological-parent families (ref.)		---	---	---	---	---
Step families		1.46***	1.27***	1.25***	1.31**	1.17
Single-parent families		1.32***	1.11	1.11	1.20*	1.03
Other families		1.10	0.96	0.93	1.10	0.86
Family income		1.00	1.00	1.00	1.00	1.00
Mother-child closeness			1.02	1.02	1.01	1.04+
Positive family climate			0.93***	0.94***	0.95**	0.94**
Self-reported grades			0.82***	0.81***	0.76***	0.86**
School adjustment			0.99	0.99*	0.97**	1.01
Self esteem			1.02*	1.01	1.02	1.01
Religiosity			0.99	0.98+	0.97*	0.98
R's attractiveness			1.17***	1.11***	1.09*	1.13*
Motivation to have sex			1.04***	1.04***	1.04***	1.04**
Perceived social consequences of sex			0.91***	0.92***	0.91***	0.94**
Feelings of social marginalization				0.95**	0.93**	0.97
Number of received friendship nominations				1.03***	1.04**	1.03**
Closeeness with same-sex friends				1.02**	1.01+	1.02*
Closeeness with opposite-sex friends				1.01	1.02*	1.00
Participate in a team sport in past week				1.07**	1.03	1.12***
Ever had a romantic relationship				1.72***	1.90***	1.47***
Total person years	23221	23221	23221	23221	13454	9767

+ p< .10; * p< .05; ** p<.01; p< .001

Table 2: Multinomial logistic regression models predicting sexual relationship trajectories, Add Health data (multiply and imputed data), N=6,905

| (Reference: Never-had-sex trajectory) | Model 1 | | | Model 2 | | | Model 3 | | | Model 4 | | |
	High risk	Always1	0->1	High risk	Always1	0->1	High risk	Always1	0->1	High risk	Always1	0->1
Weight Statuses												
Underweight	0.25	0.58*	0.78	0.27	0.63+	0.82	0.25	0.65	0.87	0.30	0.76	0.96
Normal Weight (ref.)	--	--	--	--	--	--	--	--	--	--	--	--
At risk of overweight	0.99	0.92	0.88	0.98	0.87	0.86	0.96	0.86	0.87	1.19	1.01	0.95
Overweight	0.50*	0.61***	0.75*	0.48*	0.56***	0.73*	0.50+	0.60**	0.77+	0.68	0.75+	0.87
Age at w2	1.19*	1.11*	0.84***	1.22*	1.13*	0.84***	1.17+	1.10+	0.85***	1.14***	1.09	0.85***
Male	0.68	0.98	0.99	0.68	1.00	0.99	0.28***	0.59***	0.74**	0.34	0.68*	0.75*
Race												
White (ref.)				--	--	--	--	--	--	--	--	--
Black				1.00	1.29	1.03	0..85	1.10	0.92	1.39	1.58*	1.09
Hispanics				0.51	0.80	1.00	0.43+	0.69*	0.92	0.48	0.75	0.94
Other				0.62	0.43***	0.67*	0.57	0.42***	0.65*	0.83	0.56**	0.76
Maternal Education												
Less than High School (ref.)				--	--	--	--	--	--	--	--	--
High School				1.41	0.98	1.02	1.37	0.95	0.97	1.18	0.82	0.89
Some College				0.96	0.93	1.08	0.92	0.93	1.04	0.71	0.73	0.91
College and beyond				1.03	0.66*	0.85	1.21	0.74+	0.86	0.88	0.55**	0.73+
Family Structure												
Two-biological-parent families (ref.)				--	--	--	--	--	--	--	--	--
Stepfamilies				2.98**	2.29***	1.62**	1.95+	1.72**	1.42*	1.92+	1.75**	1.44*
Single-parent families				1.89*	1.57**	1.24	1.17	1.13	1.06	1.11	1.11	1.05
Other families				1.48	1.25	0.84	1.01	0.98	0.77	0.76	0.88	0.72
Family income				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Mother-child closeness							1.08	1.04	1.07*	1.09	1.04	1.07+
Positive family climate							0.74***	0.84***	0.90*	0.76***	0.86**	0.91*
Self-reported grades							0.62**	0.63***	0.80**	0.59**	0.59***	0.76**
School adjustment							0.98	1.00	1.01	0.96	0.99	1.00
Self esteem							1.06*	1.05**	1.02	1.03	1.03	1.01
Religiosity							0.93	0.98	1.00	0.91	0.96	0.98
R's attractiveness							1.45**	1.40***	1.28**	1.25	1.25*	1.20*
Motivation to have sex							1.17***	1.08***	1.05+	1.17**	1.08**	1.04
Perceived social consequences of sex							0.77***	0.82***	0.89**	0.80**	0.84***	0.90**
Feelings of social marginalization										0.87	0.90*	1.00
Number of received friendship nominations										1.08*	1.08***	1.05**
Closeeness with same-sex friends										1.03	1.05**	1.03+
Closeeness with opposite-sex friends										1.05+	1.03	1.00
Participate in a team sport in past week										1.12	1.15**	1.19***
Ever had a romantic relationship										8.91***	3.84***	1.98***

p< .10; * p< .05; ** p<.01; p< .001