

# The ARCHER study of health and wellbeing in young rural Australians

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## Abstract

**Aims:** To provide an overview of preliminary findings from the longitudinal ARCHER (Adolescent Rural Cohort study of Hormones, Health, Education, Environments and Relationships) study of rural adolescent health.

**Methods:** The ARCHER study is a three-year multidisciplinary longitudinal rural study of adolescents (recruited at 9 to 14 years) from two regional centres in the Central West of NSW. The ARCHER study includes an extensive yearly survey of adolescents and their parent(s)/guardian using questionnaires, anthropometry, blood and urine collection. Measures include universal aspects of adolescent health and wellbeing, such as education, health risk behaviours, mental and physical health. Data analysis was performed to explore trends over time and by age.

**Results:** 342 young people were recruited to ARCHER with 82% retention across four Waves of data collection over 3 years. At baseline, the median age was 11 years, 45% were female and 11% were Aboriginal or Torres Strait Islander adolescents. Serum testosterone and oestradiol levels confirmed that the majority of the adolescents were in early puberty. The young people came from diverse socioeconomic backgrounds, although participating families were generally more affluent and better educated than the broader regional population. Across the four Waves, between 10 and 18% experienced significant depressive symptoms and rates increased with age. According to parents/guardians, only approximately 1 in 10 young people met national guidelines for physical activity, and between 16 to 22% lived in a household with at least one smoker. Prevalence of overweight and obesity ranged from 26 to 28% overall (females 29 to 32%; males 23 to 25%). Associations between gender, mental and physical health and stage of puberty were present.

**Relevance:** Adolescence is a critical epoch laying durable foundations for lifelong health and wellbeing. Understanding and promoting rural adolescent health and wellbeing will contribute to addressing known rural health inequities.

**Conclusions:** We have successfully recruited and maintained a cohort to answer novel research questions. Data generated will further our understanding of puberty and its effects as well as providing insight into the specific determinants of health for young people growing up in rural Australia.

## Introduction

Adolescence is a critical phase of life that involves complex biological, physical, cognitive and social changes for the young person. These changes combine and interact with environmental factors such as socioeconomic status, education and familial/peer relationships to potentially alter trajectories of future health and wellbeing (Sawyer et al., 2012; Viner et al., 2012). Puberty is the biological event defining early adolescence. Many assumptions and assertions are made about the authentic,

underlying biological effects of the major puberty hormones—testosterone in males and oestradiol in females—on adolescent health, wellbeing and behaviour. To date, the definitive longitudinal studies with appropriately frequent measures of puberty hormones have yet to be reported. Most studies rely on physical staging of puberty, a late effect of puberty hormone action (Dorn et al., 2006). The effect of arguably the most dramatic hormone changes in life and their interactions with other determinants of health and changes in adolescence remain poorly understood. Additionally, the frequency of many characteristic behaviours and recognised morbidities of adolescents increase after the physical events of puberty are complete. These observations suggest that the individual patterns of puberty hormones—both timing and tempo—may be influential. This is the hypothesis of the ARCHER study (**A**dolescent **R**ural **C**ohort study of **H**ormones, **H**ealth, **E**ducation, **E**nvironment and **R**elationships) which aims to identify the genuine biological influence of puberty hormones on adolescent health, wellbeing and behaviour (Steinbeck et al., 2012).

Although about one-third of 10 to 13 year olds live in regional or remote areas (32.8%; ABS, 2011), the health determinants of Australian rural and regional adolescents are poorly documented and under-researched. Known inequalities of rural populations include lower incomes, poorer levels of education and employment and access to services. The further from metropolitan areas young people live the higher the burden of disease and mortality rates, accidents are more common, diet is poorer, there are greater levels of alcohol abuse and poorer access to health care (AIHW, 2011). These inequalities in social determinants of health and the specific health needs of young people in non-metropolitan areas are not well understood.

This preliminary analysis of the ARCHER study focusses on several important aspects of adolescent health from the myriad studied, namely sleep, depression and overweight and obesity (O&O). It is well recognised that sleep patterns change during adolescence. Adolescents tend to have decreased total sleep duration and increased differences between weeknight and weekend sleep (Owens, 2014). The known consequences of their poor sleep are wide-ranging and include poorer academic achievement, increased risk-taking behaviours, obesity and poorer mental health (Chaput et al., 2016; Shochat et al., 2014). This time in life is also characterised by substantial cognitive, social-cognitive and social-organisational changes that have significant implications for academic wellbeing, including lower academic motivation and engagement (Martin, 2009; Martin et al., 2015). Depression is the leading cause of disability amongst young people worldwide (WHO, 2014). During adolescence, the prevalence of depression increases, which is commonly attributed to puberty, although empirical evidence is almost entirely lacking (Balzer et al., 2015; Duke et al., 2014). The impacts of depression in young people include poor functioning at school or work, poor relationships with family and friends, risk-taking behaviour and suicide (Lawrence et al., 2015). The prevalence of O&O increased substantially in young Australians during the latter part of the 20th century, similar to global trends (Hardy et al., 2011; Ng et al., 2014). Although this increase appears to have plateaued in Australia in the last decade (ABS, 2013a), adolescent O&O remains an important public health issue. Australia has one of the highest rates of youth obesity among developed countries (Ng et al., 2014). Reduced physical activity is also a well-known risk factor for O&O. The Australian National Guidelines for Physical Activity and Sedentary Behaviour recommend moderate to vigorous activity for at least 60 minutes every day of the week (Australian Department of Health, 2014).

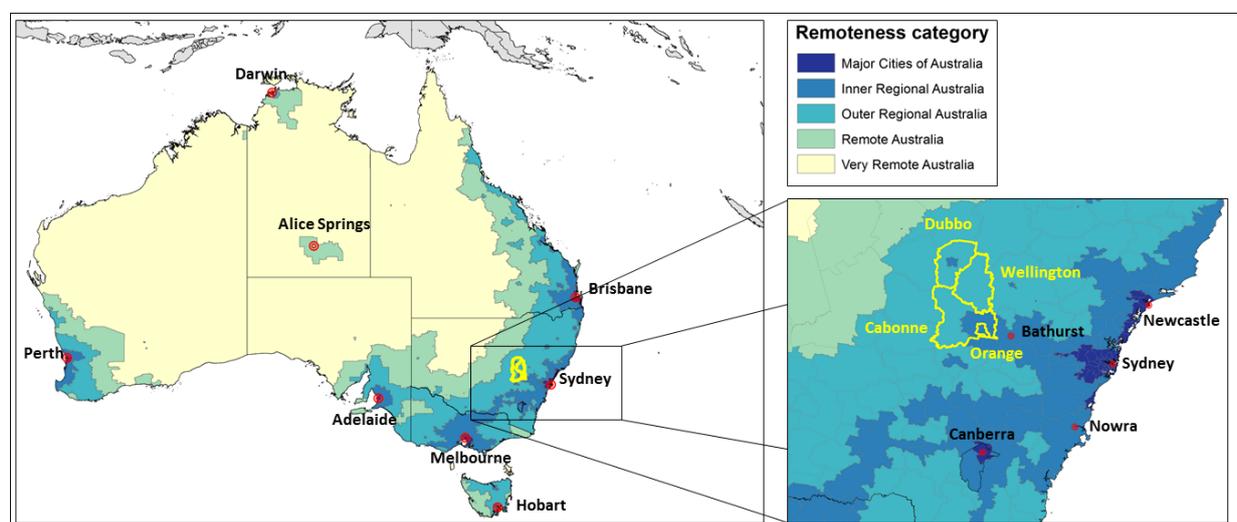
The known contribution of adolescent health and health-related behaviours to adult health and wellbeing, and the dearth of research particularly into rural youth, emphasise the importance of this unique ARCHER cohort. This paper provides an overview of this rural youth cohort including: i) hormones and pubertal status; (ii) physical health, health risk behaviours, sleep and environment; (iii)

mental health; and (iv) overweight and obesity; and examines predictors of mental health and overweight and obesity in this rural sample.

## Methods

The detailed methodology of the multidisciplinary ARCHER study has already been published (Steinbeck et al., 2012). Briefly, young people in school years 5 to 7, and their parents/guardians, were recruited from two regional centres, Dubbo and Orange, in the state of New South Wales, Australia and surrounding rural areas (see Figure 1). Recruitment was primarily through schools, with information sent home to parents/guardians. Other recruitment methods included flyers on community noticeboards, through sporting clubs and through local digital and print media. The lower year 5 school limit was selected to ensure that participating adolescents were capable of self-report yet were captured before puberty was too advanced. Annual surveys of both adolescents and parents/guardians included demographics (individual and household), socioeconomic factors, sleep patterns, health risk behaviours, mental health and physical activity/lifestyle factors. Young people were asked to complete the Short Mood and Feelings Questionnaire (SMFQ; Angold et al., 1995) and high levels of depressive symptoms were defined by scores of 11 or higher. They self-reported their Tanner stage and answered a question on perceived stage of pubertal development: “Compared to other kids your age and sex, what is your stage of puberty?” responding either ‘behind’, ‘the same’ or ‘in front’.

Figure 1 Australian Remoteness Areas (with detail for the Central West of NSW)



Source: ABS Australian Standard Geographic Standard (ASGS) Digital Boundaries; ABS, 2013b.

In addition, data on anthropometry and puberty hormones in serum were collected annually from adolescents (only Wave 1 serum hormones are available at this stage). Serum testosterone and oestradiol were measured by liquid chromatography, mass spectrometry (PMID 19747904, 26090565). Weight was measured using Tanita TBF-300 Pro Body Composition Analyzer. Height was measured on a portable stadiometer (to 0.1 cm) using standard techniques. Body Mass Index ( $\text{kg}/\text{m}^2$ ) was converted to grades of thin, normal weight, overweight and obese using the International Obesity TaskForce cut-offs for age and sex (Cole and Lobstein, 2012). The study population all completed the baseline questionnaires and measurements between June 2011 and August 2013. Participation rates are shown in Table 1. While the overall retention rate was 82% ( $n=281/342$ ), between adjacent

Waves the retention ranged from 92% to 95%. Participants' baseline characteristics were compared with data for local government areas (LGAs) containing over 5% of ARCHER households. These included Cabonne, Dubbo, Orange, and Wellington. From the 2011 Census, there were 5,754 adolescents aged 10 to 13 years resident in these four LGAs, 24,690 parents (aged 30 to 49 years) of adolescents aged 10 to 13 years and 35,258 dwellings.

Table 1 Young ARCHER participants with complete survey data over four annual Waves of data collection

	Enrolled	Survey data available
Wave 1	342	339
did not continue/moved out of area	27	
skipped Wave 2 (rejoined Wave 3)	1	
Wave 2	314 (91.8%)	313
did not continue/moved out of area*	18	
skipped Wave 3 (rejoined Wave 4)	1	
Wave 3	296 (94.3%)	295
did not continue/moved out of area	18	
Wave 4	281 (94.9%)	281

\* n=2 joined study at Wave 4

N.B. % represents proportion retained from previous Wave.

### Data analysis

Measures of central tendency and dispersion are given as medians and interquartile ranges (IQR) due to skewed distributions for age, age at menarche and total sleep times. Associations between categorical data were estimated using the chi-squared test. Paired comparisons across the four Waves for typical hours slept on weekdays and on weekends were made using the non-parametric Friedman Test. Sleep compensation was defined as sleeping at least one hour longer on weekends than on school nights, and was based on self-reported total sleep time (TST). The relationship between age and sleep compensation was explored using a Spearman's correlation ( $r_s$ ). Separate generalised estimating equation (GEE) models were used to predict depressive symptoms and O&O across the four Waves of data. Variables included in each of the regression models were age, socioeconomic status (highest household occupation), number of days of moderate to vigorous physical activity (MVPA, self-reported), self-reported TST during school nights and during the weekend, and either Tanner stage or perceived comparative stage of pubertal development (same, behind or in front). All analyses were carried out using IBM SPSS Statistics v24. Alpha was set at 0.05 for all comparisons.

### Ethics

Approval for the ARCHER study was granted by The University of Sydney Human Research Ethics Committee (HREC 13094 approved 2010). Both parental (or guardian) consent and child assent to participate were obtained.

### Results

Median age of the 342 young participants at baseline was 11 years, 45% were female and 11% were Aboriginal or Torres Strait Islander adolescents. The sample was representative of the region in terms of gender (proportion in LGA 49% female), but slightly underrepresented youth of Aboriginal background (proportion in LGA 17%). The young people came from diverse socioeconomic backgrounds. Approximately a quarter (26%) of households included an adult with a managerial

occupation, whereas for 17% the highest household occupation was sales, machinery operation, labouring or home duties. In comparison to the LGAs, participating families were generally more affluent (more likely to be employed: ARCHER 87% vs LGA 81%; and to own a house: ARCHER 80% vs LGA 68%) and better educated (ARCHER 49% with tertiary education vs LGA 20%). Only one young person had left school at Wave 4.

**Puberty and hormones**

The majority of the adolescents were in early puberty according to testosterone and oestradiol levels in plasma at baseline (Wave 1) (see Figures 2a-b). Fifty six percent of females and 49% of males rated themselves as pre-pubertal or early-pubertal (Tanner stage 1 to 2; see Table 2). Just under one quarter of females (23.2%) and 10.1% of males rated their stage of puberty as ‘behind’ compared to others their age and sex (see Table 2).

Figure 2a Serum testosterone (nmol/L) at baseline for males (n=166)

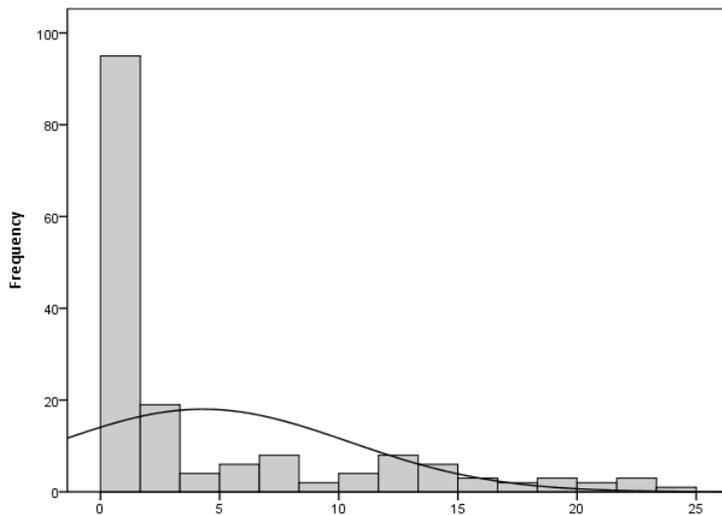


Figure 2b Serum oestradiol (pmol/L) at baseline for females (n=133)

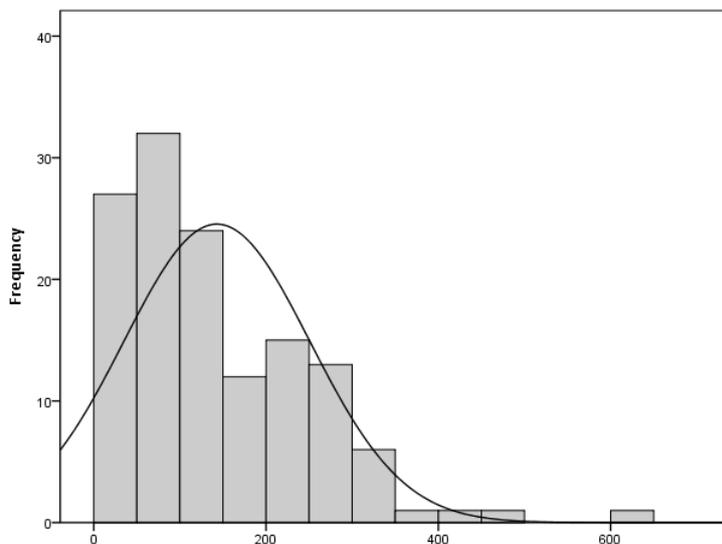


Table 2 Pubertal stage at baseline, by age group and sex

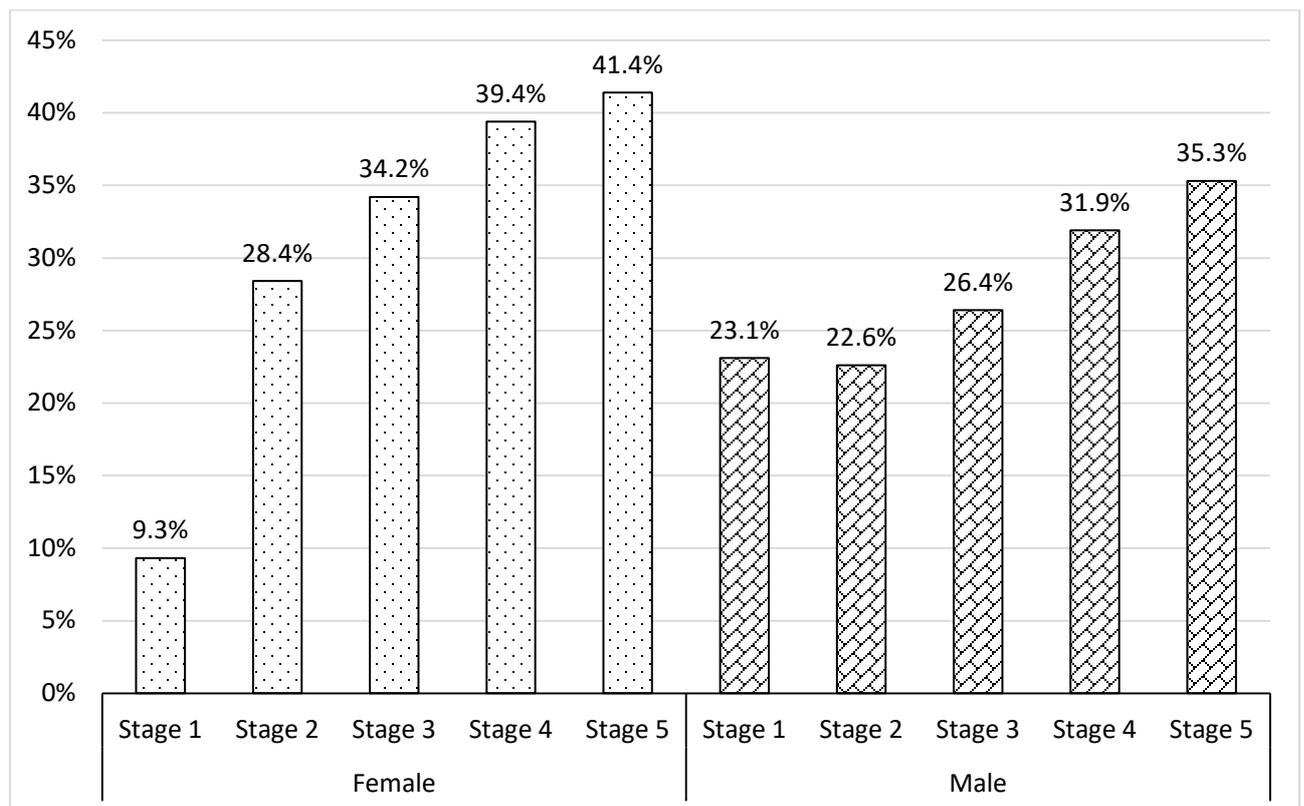
	9 to 10 years (n=88)	11 to 12 years (n=202)	13 to 14 years (n=49)
Tanner Stage 1 or 2	77.3%	51.8%	8.2%
Females	84.6%	54.3%	5.6%
Males	71.4%	49.5%	9.7%
Perceived comparative stage of puberty			
Behind	23.9%	15.8%	2.0%
Same	60.2%	65.8%	77.6%
In Front	15.9%	18.3%	20.4%
<i>Females</i>			
Behind	33.3%	22.3%	5.6%
Same	51.3%	60.6%	72.2%
In Front	15.4%	17.0%	22.2%
<i>Males</i>			
Behind	16.3%	10.2%	0.0%
Same	67.3%	70.4%	80.6%
In Front	16.3%	19.4%	19.4%

### **Physical health, health risk behaviours and sleep**

According to parent/guardian reports, only approximately 1 in 10 young people met national guidelines for physical activity (i.e. at least 60 minutes every day of moderate to vigorous physical activity) (8.5 to 11.2% across the study Waves). In contrast, between 13.5 and 23.7% of young people reported at least 60 minutes of MVPA each day. Across the four time points, between 16.3 and 21.5% lived in a household with at least one smoker. The proportions of young people reporting smoking 'even part of a cigarette' (but more than 'just a few puffs') increased from 1.5% (n=5/339) at Wave 1 to 7.5% (21/281) at Wave 4. The proportions reporting having had even part of an alcohol drink, beyond a few sips, was 2.1% (7/339) at Wave 1, and rose to a quarter of the sample (24.9%, 70/281) by Wave 4. Other drug use was minimal, with no reported amphetamine use at all, and marijuana use between 0.6% and 3.2% across the Waves. Approximately one in five (19.3%) young people reported having an illness, disability or handicap at least once during the study (point prevalence between 6.8% and 11.8%). Of these 66 young people, 42% (n=28) reported having asthma.

Total sleep hours decreased across the four Waves: from a median for weekdays of 10 hours down to 8.8 hours ( $p < 0.001$ ) and on weekends from 9.3 hours down to 9 hours ( $p < 0.01$ ). Across the Waves, sleep compensation (sleeping at least one hour longer on weekends than on school nights) was reported by between 26.7% and 40.9% of adolescents. The difference in weekend and school night total sleep hours was significantly positively correlated with age ( $r_s = 0.15$ ,  $p < 0.001$ ), indicating increased compensation with age. There was also increased weekend sleep compensation by Tanner stage for both females and males (see Figure 3).

Figure 3 Weekend sleep compensation by sex and Tanner Stage

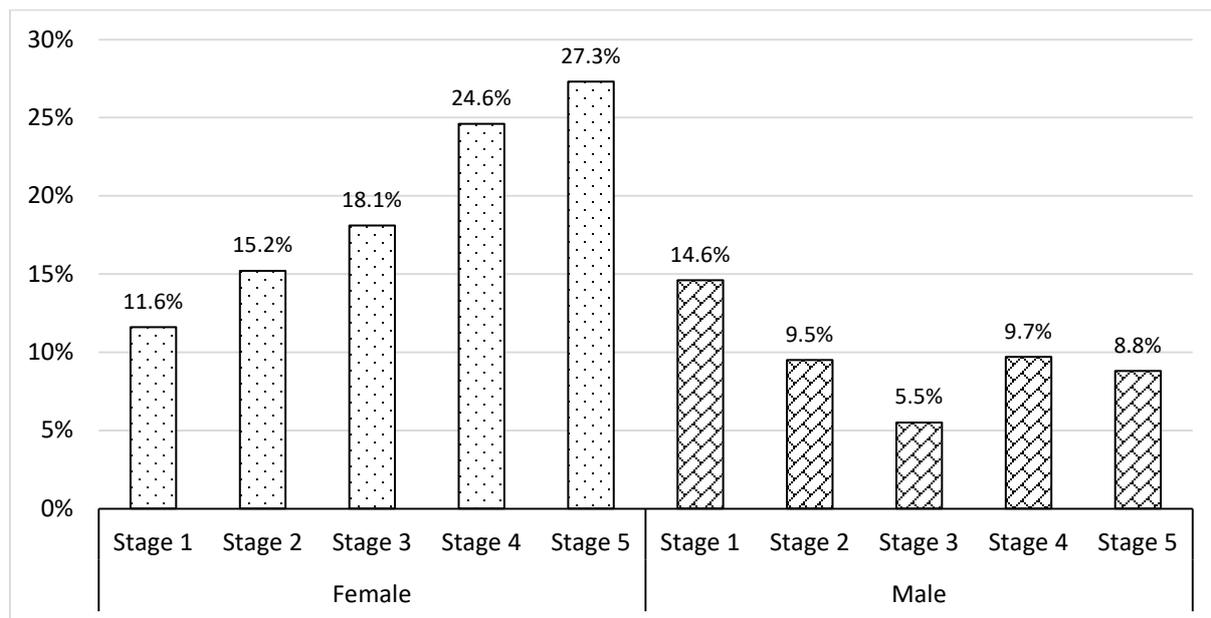


Data are regardless of Wave; N=1,195.

### Mental health

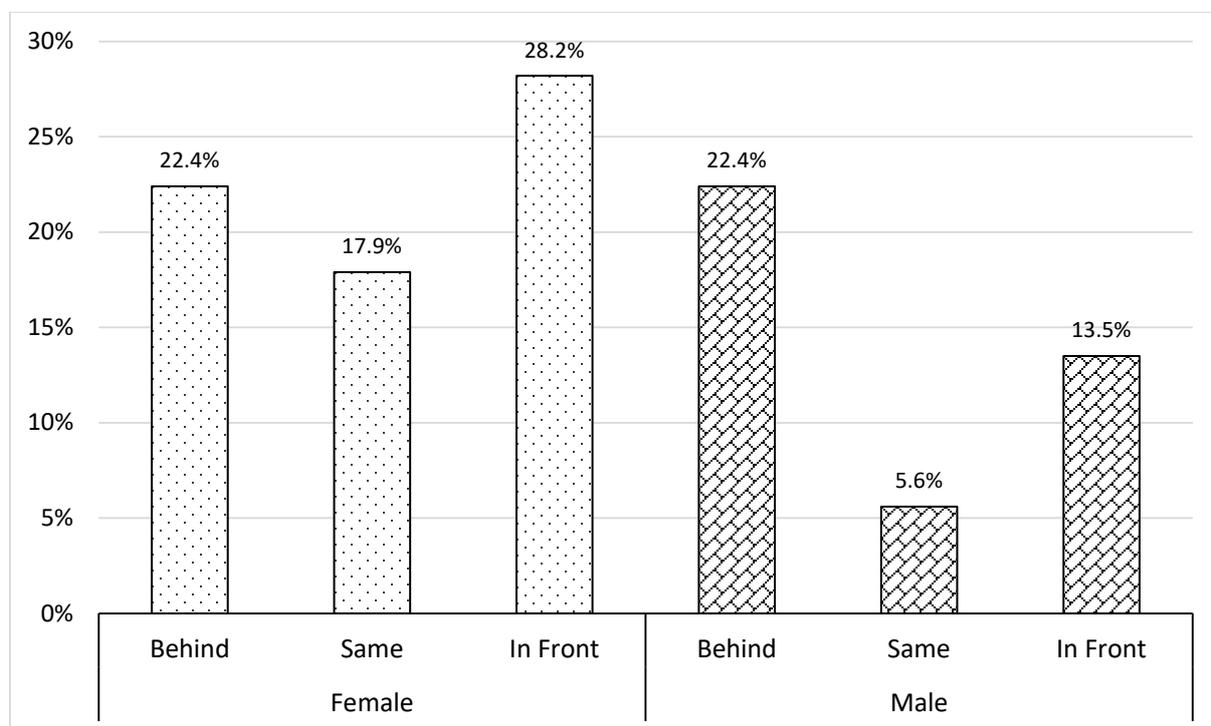
Just under a third (30.7%) of young people had experienced significant depressive symptoms over the four Waves, with point prevalence ranging from 10.5% (Wave 2) to 18.1% (Wave 4). Depression increased in prevalence with age: 12.0% of 9 to 11 year olds, 13.9% of 12 to 14 year olds and 17.2% of 15 to 17 year olds. For females, depressive symptoms increased in prevalence with advancing Tanner stage (12% at stage 1 and 27% at stage 5;  $p < 0.01$ ), whereas for males there was no clear pattern (see Figure 4a). Perceptions of comparative pubertal development were associated with depressive symptoms for males ( $p < 0.001$ ). Among young males who perceived themselves as 'behind' the pubertal stage of their peers, 22% had depressive symptoms compared to 14% of those who thought they were 'in front' and 6% of those 'the same' as others (see Figure 4b). The association of perceived pubertal stage was not significant in females.

Figure 4a Significant depressive symptoms by sex and Tanner Stage



Data are regardless of Wave; N=1,216.

Figure 4b Significant depressive symptoms by sex and perceived comparative stage of puberty



Data are regardless of Wave; N=1,225.

**Overweight and obesity**

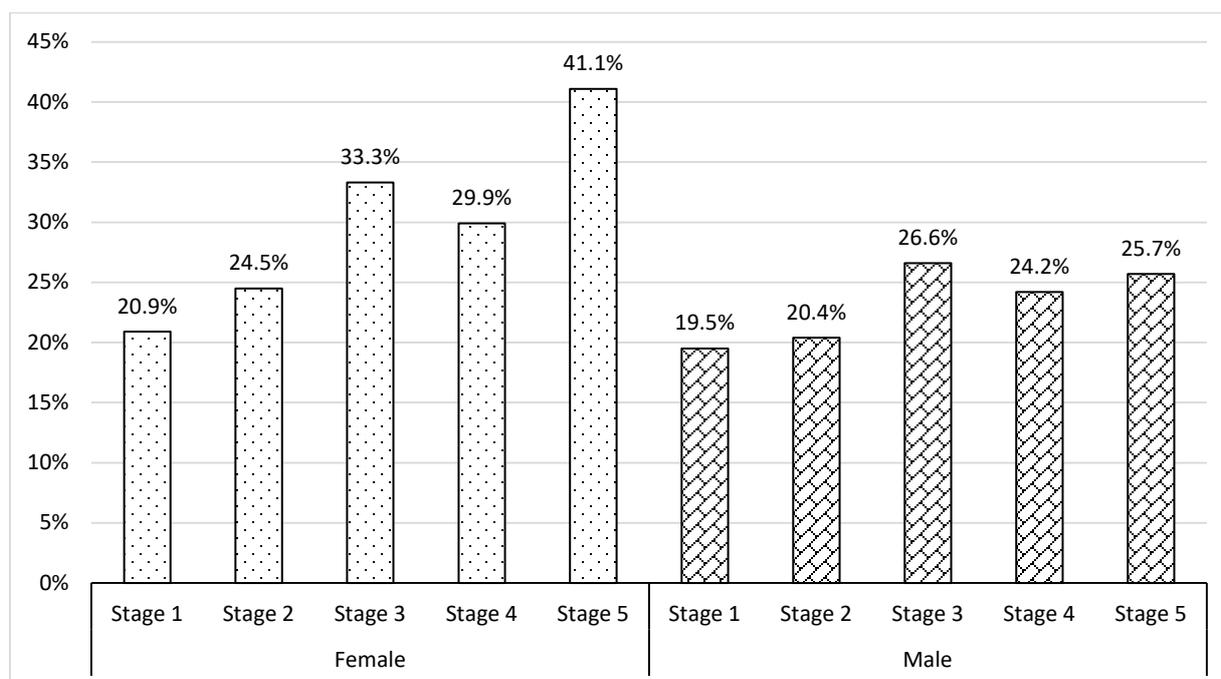
Prevalence of O&O ranged from 26.4 to 28.1% across the Waves (see Table 3). While prevalence of O&O was always higher in females (females: 29-32% vs males: 23-25%), it was not significantly higher than males during any Wave. O&O was significantly associated with increasing Tanner stage

in females ( $p < 0.05$ ), but not males (see Figure 5a). For females who thought their pubertal stage was behind others their age and sex, 16% were O&O, compared to 31% of those 'the same' and 52% of those 'in front' ( $p < 0.001$ ). For males, the rates of O&O for those 'behind' were 22%, 'the same' 23% and 'in front' 31%, not a significant pattern (see Figure 5b).

Table 3 International Obesity Task Force BMI grades, across the four Waves

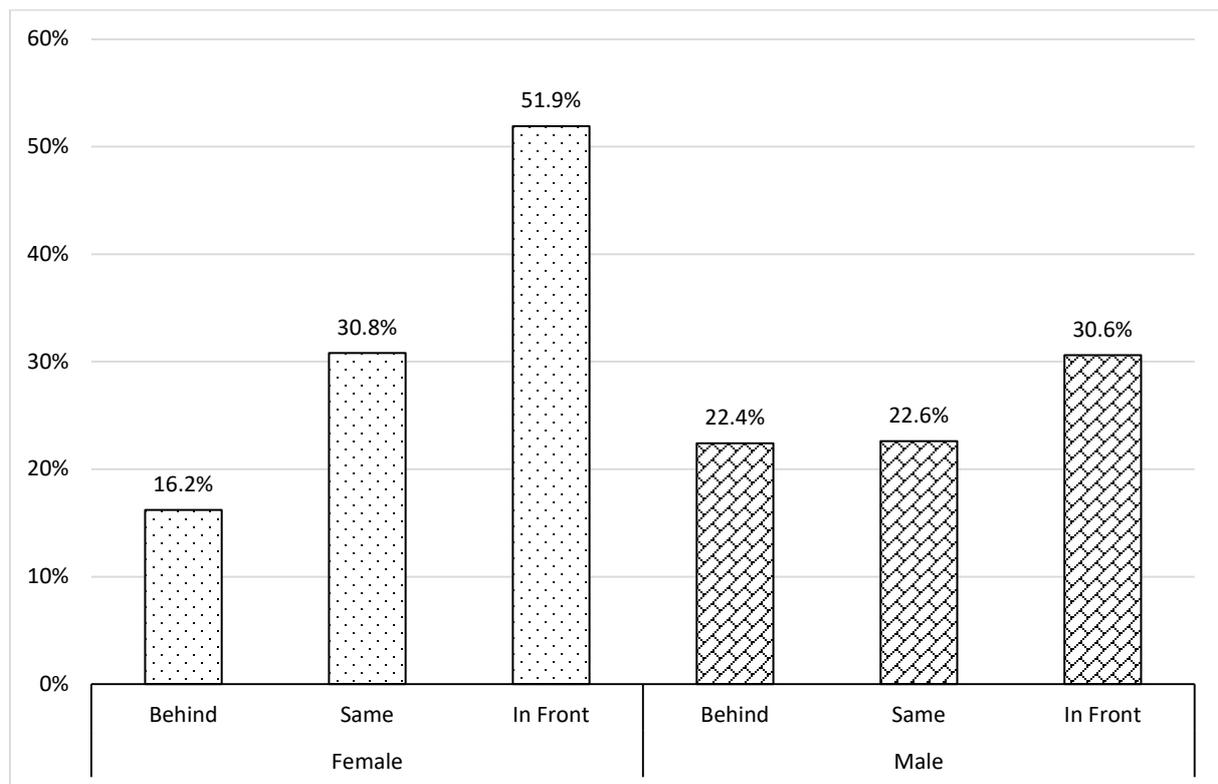
	Wave 1 (n=341)	Wave 2 (n=313)	Wave 3 (n=293)	Wave 4 (n=274)
Thin	6.5%	7.3%	5.8%	8.4%
Normal	67.2%	66.5%	66.2%	63.5%
Overweight	17.3%	18.2%	18.4%	17.9%
Obese	9.1%	8.0%	9.6%	10.2%

Figure 5a Overweight and obesity by sex and Tanner Stage



Data are regardless of Wave; N=1,203.

Figure 5b Overweight and obesity by sex and perceived comparative pubertal stage



Data are regardless of Wave: N=1,212.

Age at menarche was available for 84% of females, and the median age was 13 (IQR 1.7). One-fifth (26/129) reached menarche before 12 years, 27.1% between 12 and < 13 years and 52.7% from 13 years onwards. Considering data from all Waves, there was a significant relationship between age at menarche and O&O, 45.9% (n=45/98) of those having an earlier (before 12 years) menarche were O&O, compared with 29.7% (35/118) in the average age menarche group and 26.1% (63/241) in the later (13 years onwards) menarche group ( $p < 0.01$ ).

#### Predictors of mental health

Models were developed to predict mental health (SMFQ significant depressive symptoms) over the four Waves. Depressive symptoms in females was associated with greater age, lower SES and fewer hours sleep on weekdays. Depression in males was associated with perceived pubertal stage, with significantly lower odds of depressive symptoms if perceived stage was 'the same', compared to perceiving self to be 'behind' (OR 0.25, 95% CI 0.10-0.58) (see Table 4).

#### Predictors of O&O

Tanner stage and perceived comparative pubertal stage were significant predictors for female O&O, but not males (see Table 5), with increased odds of O&O with higher Tanner stage or perceiving self as 'same' or 'in front' compared to being 'behind' peers in pubertal development. Weekend total sleep time was a significant predictor for males but not females, with O&O males having shorter weekend TST (median 8 hours) than normal weight males (median 9 hours). Self-reported MVPA was a significant predictor for both sexes, with O&O associated with fewer days of sustained physical exercise.

Table 4 Odds of significant depressive symptoms (SMFQ) across the four Waves

SMFQ caseness	Females		Males	
	Odds ratio (95% confidence interval)		Odds ratio (95% confidence interval)	
	Model 1	Model 2	Model 1	Model 2
Age	1.24 (0.98-1.57)	1.23 (1.04-1.46)†	1.02 (0.74-1.41)	1.04 (0.79-1.37)
SES	1.19 (1.03-1.37)†	1.19 (1.04-1.37)†	1.12 (0.97-1.29)	1.11 (0.96-1.29)
MVPA (SR)	1.02 (0.90-1.17)	1.01 (0.89-1.16)	0.94 (0.80-1.10)	0.96 (0.81-1.13)
School night TST	0.75 (0.62-0.91)‡	0.75 (0.62-0.91)‡	1.17 (0.85-1.60)	1.14 (0.84-1.55)
Weekend TST	0.85 (0.72-1.01)	0.86 (0.73-1.02)	0.84 (0.69-1.03)	0.86 (0.70-1.07)
Tanner Stage				
Stage 1	1.00		1.00	
Stage 2	1.10 (0.23-5.15)		0.51 (0.17-1.51)	
Stage 3	0.81 (0.16-4.18)		0.37 (0.10-1.46)	
Stage 4	1.11 (0.20-6.09)		0.68 (0.21-2.25)	
Stage 5	0.81 (0.12-5.26)		0.59 (0.15-2.31)	
Comparative Stage				
Behind		1.00		1.00
Same		0.63 (0.32-1.24)		0.25 (0.10-0.58)‡
In Front		0.99 (0.46-2.12)		0.62 (0.25-1.57)

Model 1 includes Tanner stage as a predictor; Model 2 includes Comparative stage of pubertal development as a predictor.

MVPA (SR), moderate to vigorous physical activity, self-reported

SES, Socioeconomic Status, higher ratings indicate poorer SES

SMFQ, Short Mood and Feelings Questionnaire

TST, total sleep time.

† p < 0.05; ‡ p < 0.01

Table 5 Odds of Overweight and Obesity across the four Waves

O&O	Females		Males	
	Odds ratio (95% confidence interval)		Odds ratio (95% confidence interval)	
	Model 1	Model 2	Model 1	Model 2
Age	0.73 (0.56-0.95)†	0.89 (0.74-1.07)	1.04 (0.83-1.30)	1.08 (0.93-1.25)
SES	1.10 (0.93-1.32)	1.12 (0.94-1.34)	0.96 (0.82-1.14)	0.97 (0.82-1.14)
MVPA (SR)	0.82 (0.73-0.93)‡	0.83 (0.74-0.93)‡	0.88 (0.78-0.99)†	0.88 (0.77-0.99)†
School night TST	0.89 (0.73-1.09)	0.86 (0.71-1.05)	1.11 (0.93-1.32)	1.11 (0.94-1.32)
Weekend TST	0.92 (0.77-1.11)	0.95 (0.80-1.14)	0.85 (0.76-0.95)‡	0.85 (0.76-0.95)‡
Tanner Stage				
Stage 1	1.00		1.00	
Stage 2	1.45 (0.55-3.83)		0.84 (0.30-2.39)	
Stage 3	2.68 (0.86-8.35)		1.40 (0.45-4.37)	
Stage 4	2.67 (0.71-10.1)†		1.16 (0.34-3.90)	
Stage 5	5.95 (1.30-27.3)†		1.23 (0.30-5.00)	
Comparative stage				
Behind		1.00		1.00
Same		2.37 (1.25-4.49)‡		1.31 (0.71-2.40)
In Front		5.48 (2.43-12.4)P		2.00 (0.94-4.28)

Model 1 includes Tanner stage as a predictor; Model 2 includes Comparative stage of pubertal development as a predictor.

MVPA (SR), moderate to vigorous physical activity, self-reported

SES, Socioeconomic Status, higher ratings indicate poorer SES

SMFQ, Short Mood and Feelings Questionnaire

TST, total sleep time.

† p < 0.05; ‡ p < 0.01; P < 0.001

## Discussion

Special features of the ARCHER study are its rural location and large sample size for a study which involves intense biological sampling and family data collection. Few other studies nationally or internationally have achieved this sample size or focussed on rural young people. Three local birth cohorts, Dunedin and Christchurch from New Zealand (Marie et al., 2008; Poulton et al., 2006), and Raine from Western Australia (McKnight et al., 2012) have less frequent review and/or limited biological data collection. The Copenhagen Puberty study includes 4,000 children, of which only 209 provided consent for six-monthly blood samples (Aksghlaede et al., 2009).

The strengths of the ARCHER study are the detailed description of biological puberty, the data collection from both adolescents and their parents and the high retention in the study. An additional strength of the ARCHER study is that the data are obtained from young people growing up in regional and rural NSW, Australia. This location allows the investigators to consider additional aspects of rural health. The local community, including young people, have been involved since the conception of the study through ARCHER Community Consultative Committees and focus groups (Cooper Robbins et al., 2012). Their input has guided the study questions, methods, recruitment and retention, an additional strength of this cohort study. The ARCHER cohort is not a representative population sample. As with all recruitment into adolescent longitudinal studies with an intensive biological sampling methodology (Jeffery et al., 2012; Sorensen et al., 2010) the makeup of the sample is largely dictated by those who volunteer, and may therefore have some selectivity which may create participation bias.

The present analysis demonstrates that there is sufficient power and variability in the ARCHER study to draw conclusions about the biological effects of puberty hormones while also providing a sample that is both diverse and has the capacity to report on a range of rural and regional adolescent determinants of health, health risk factors and outcomes. The collection of the detailed annual questionnaires and anthropometry with the biological data in the ARCHER study will allow for the first time, the future investigation of the interactions of puberty hormones with the social, environmental and cultural factors that impact on and determine adolescent physical and mental health. To provide a clear description of the individual tempo of puberty the ARCHER study will use mass spectrometry-based urinary steroid assays to monitor hormone change in participant's urine at three monthly intervals.

This cohort exhibits expected adolescent behaviours and outcomes including changing sleep patterns, increases in health risk behaviours (such as smoking and alcohol consumption), mental health symptoms and O&O. A substantial proportion of the cohort were captured in early puberty, as indicated by serum hormones and self-report. This is important in order to study the longitudinal relationship between puberty and health. We demonstrated known relationships between pubertal stage and obesity in females. Interestingly, recent reports indicate an association between higher androgens and obesity in adolescent females (Cree-Green et al., 2015). However, models in this paper only used self-reported pubertal staging and perceived comparative development. Once longitudinal serum hormone data are available, the ARCHER study will be able to investigate relationships between the timing and tempo of puberty and health outcomes.

The predictive models in this study demonstrate the complex inter-relationships between physical and social determinants of health, with household socioeconomic status an important factor for female mental health and sleep having a relationship with both mental health and O&O. Specifically, increased school night sleep was associated with lower odds of significant depressive symptoms in

females and increased weekend sleep with lower odds of O&O in males. There is little known about sleep in rural adolescents, which may be affected by specific rural determinants or cultural values and attitudes towards health risk behaviours (Reichenberger et al., 2016). To the authors' knowledge this is the first study in rural Australian adolescents.

Approximately 30% of the young participants in the ARCHER study experienced significant depressive symptoms at some stage of the study. While data indicate that rates of high psychological distress in secondary students in NSW are no higher in rural-regional than in metropolitan Local Health Districts (LHDs) (13.2% versus 13.4%), hospitalisations for intentional self-harm among 15 to 24 year olds are significantly higher (326.9 to 422.5 in regional and remote areas versus 280.9 per 100,000 population in major cities) (HealthStats NSW), making prevention of depression in young people an important rural public health issue. We confirmed the known relationship, for females, with pubertal development and depressive symptoms. Interestingly it was only perceived comparative pubertal stage that was an important predictor for males.

Another important public health issue for rural youth is O&O. Rates of O&O among secondary students aged 12 to 17 years in NSW in 2014 were higher in rural and regional LHDs (23.0%) than in metropolitan LHDs (19.7%) (NSW HealthStats). Little is known about any specific factors that are associated with overweight and obesity in young people living in regional and rural Australia. Rural and regional areas are diverse and differ from urban areas not only from an environmental perspective but also socioeconomically and culturally. Lower population densities, fewer transport options, and reduced access to health services challenge health promotion activities that might be effective in urban areas. More information is needed about O&O in rural and regional young people to better inform interventions (Pucius, 2008). As puberty is a risk factor for obesity (Jasik and Lustig, 2008), a study that captures early adolescence has a major scientific advantage. In the current preliminary analysis, we confirmed the relationship between physical activity and O&O, and found that pubertal factors were relevant for females and that sleep, particularly on the weekend, was a significant factor for males. This cohort provides a valuable data source to determine further, unidentified factors associated with O&O in rural adolescents.

## Conclusion

We have successfully recruited and maintained an adolescent cohort to answer novel research questions. The ARCHER study provides a unique opportunity to investigate young people as they transition through adolescence. It is already contributing to our knowledge of rural adolescent health, and will allow the future investigation of the interactions of puberty hormones with the social, environmental and cultural factors that impact on and determine adolescent physical and mental health. Data generated will further our understanding of puberty and its effects as well as providing insight into the specific determinants of health for young people growing up in non-metropolitan NSW and importantly will allow for the development of appropriate, targeted interventions in at risk groups.

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