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Individual, behavioural and environmental pathways to adolescent obesity

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Chapter One

Introduction

Obesity is a condition of excess body fat accumulation which has serious physical, psychological, health, behavioural, social and economic consequences (WHO, 2005). Over the past decades there has been an explosion in the number of children and adults who are overweight or obese worldwide (WHO, 2006), with similar trends in Australia (Australian Bureau of Statistics, 2009). Most alarmingly, overweight and obese children are presenting with adult-related health disease and once reaching adulthood have an increased risk of premature death and disability (WHO, 2006).

Despite the high level of interest in the obesity epidemic, researchers have been unable to determine strong causal factors of obesity. Research teams are considering obesity from numerous perspectives such as prevalence, causation, health consequences and intervention programs from birth to adulthood. Biological, metabolic, behavioural and psychosocial perspectives are used in an effort to identify key factors linked to obesity, with little consensus. Findings are often conflicting due to variation in population groups, measurement methods, population sampling and research designs. Unfortunately evidence is accumulating on the impact of obesity on individual quality of life, increased disease risks, the growing drain on health services, and the mounting associated costs to the individual, community and country.

The causes of obesity are complex and dynamic and research aims to identify its determinants and consequences (Hu, 2008e). Obesity is considered to have developmental origins, whereby foundations for this chronic disease begin early in life (Gillman, 2008). The intra-uterine and early childhood periods are thought to influence later obesity via various inter-related pathways which include maternal behaviours and characteristics during pregnancy, early infant feeding, post-natal
growth, and early childhood behaviours such as diet and physical activity (Hu, 2008e).

While many factors have been implicated in the aetiology of obesity, the identification of causation or consequence is still unclear (Jebb & Lambert, 2000). The more commonly reported factors include adiposity rebound, birth weight, ethnicity, genetics, sedentary behaviour, physical activity, diet, socioeconomic status, parental weight status, sleep behaviour (Skinner, Bounds, Carruth, Morris, & Ziegler, 2004), early infant feeding, puberty (Watkins, Clark, Foster, Welch, & Kasa-Vubu, 2007), rapid weight gain, maternal age, prenatal environment (Blair et al., 2007), birth order, income, parent education (Hallal, Wells, Reichert, Anselmi, & Victoria, 2006), and smoking during pregnancy (Toschke, Ruckinger, Bohler, & Von Kries, 2007).

In seeking to determinate pathways to obesity, researchers have used different underlying models, such as the epidemiological triad (Hu, 2008e) and the ecological model of predictors of childhood overweight (Davison & Birch, 2001). This study is based on Social Cognitive Theory (Bandura, 2001) which provides a theoretical framework for understanding, predicting and altering human behaviour, both at an individual and population group level. Briefly, Social Cognitive Theory describes the complex inter-play of individual, environment and behaviour with reciprocal causality (Bandura, 2001; Davis, 2006; Lindzey, Hall, & Thompson, 1978). It suggests that individuals interact, rather than react with their environment throughout their lives (Bandura, 2001) through complex thoughts and actions, beliefs and competencies, and among social influences and structures. These interactions build an individual’s attention, memory, modelling and motivation (Davis, 2006). These life course approaches to investigating obesity, provide for an emphasis on developmental origins of disease, as well as the identification of risk factors at particular life stages (Hu, 2008e).

More recently, research has focussed on multi-factorial approaches to identify pathways to obesity, with a heightened call for longitudinal based research. In
particular, descriptive epidemiology enables an unfolding of patterns and trends over time (Hu, 2008b), particularly in prospective cohort studies. The cohort design is less affected by selection and differential recall bias, provides for periodic collection of data, and is considered the strongest non-randomised study design (Hu, 2008a), although considerations must be made for confounding and reverse causation (Hu, 2008d). Overall, evidence from prospective cohort studies is considered stronger than analytic epidemiological studies (Hu, 2008a).

This study utilised the data from the Western Australian Pregnancy Cohort (Raine) Study. This prospective cohort study began in 1989 recruiting pregnant women from antenatal clinics at Perth’s primary specialist obstetric clinic to measure the effects of repeated ultrasounds during pregnancy (Newnham, Evans, Michael, Stanley, & Landau, 1993). It has evolved into an ongoing health research project, collecting environmental, developmental and health information. It is one of the few cohort studies where information has been collected on children from in utero, and now with over 18 years of data, provides a unique source for investigating complex causal pathways to health outcomes (The Raine Study, 2010).

**Purpose**

Most studies of obesity have used a cross sectional design perspective. Few longitudinal studies have investigated weight status pathways, nor a multi-factorial investigation of the interplay between individual, behavioural and environmental obesogenic factors. This study aimed to address both these gaps in research.

This investigation examined multi-factorial pathways to healthy weight from an individual, behavioural and environmental perspective via a statistical process using cross-sectional and longitudinal analysis. This research involved a longitudinal investigation of the relationship between individual variables with weight status, the phase shift over time of these relationships, interrelationships between variables, and gender differences.
This study aimed to answer questions regarding individual, behavioural and environmental triggers to differences in weight status. It looked at protective behaviours; identified differences between sexes in the interplay of obesogenic influences; and provided an insight into direct and indirect parental, family and community influences, with a particular focus on the effects of physical activity, sedentary activity, physical fitness and motor ability on weight status.

**Significance**

This study contributed to the knowledge on pathways to obesity using a multifactorial approach. The focus on individual, behavioural and environmental factors may provide effective mechanisms for the future development of comprehensive rather than simplistic initiatives towards facilitating healthy weight in children, particularly from a health and education policy perspective and program development.

Behavioural and environmental factors related to obesity, such as attitudes to physical activity and the school environment, have received minimal attention, or have been adjuncts of studies. More specifically, parenting styles, which provide early foundations for children’s behaviours and the environment they grow within, have rarely been studied (Gibson, Byrne, Davis, Blair, Jacoby, & Zubrick, 2007). However, most significantly, Okely and colleagues (2004) suggest that behavioural determinants may present the most successful way of combating obesity. If this is so, then more emphasis on behaviour and environmental factors is required in research on children’s development of obesity.

Many cross-sectional, but few longitudinal studies of weight status exist, and there is a call for longitudinal data to investigate the obesogenic trends over time. “Untangling the time course of these events will require long-term prospective studies with repeated measurements of fatness, diet and physical activity” (Jebb & Lambert, 2000, p.S3). Longitudinal studies can help to unravel the
interrelationships and identify factors with similar causal pathways (Parsons, Powers, Logan, & Summerbell, 1999).

The Raine Study’s longitudinal database provided a rich array of individual, behavioural and environmental variables and offered a unique opportunity to track the time course of obesogenic factors, investigate the intricate interrelationships of these variables, following a cohort from birth to early adolescence. The characteristics of the Raine Study address the Australian research priorities of regular population monitoring and identifying influences involved in the development of unhealthy weight identified by Baur (2000). In addition, the cohort size, although variable across time points, is large (N=2868 (The Raine Study, 2010)) and provides good statistical power for analysis.

**Major Research Questions**

The key question this research addressed was:

To what extent do individual, behavioural and environmental factors during childhood contribute to weight status at early adolescence?

In answering this over-arching question, this research aimed to answer the following sub questions with respect to the Raine Study cohort.

What is the relative contribution of individual, behavioural and environmental factors to weight status at adolescence?

What is the relative contribution of individual, behavioural and environmental factors in a longitudinal model of body mass index (BMI)?

Are then any critical phase shifts in the relative contribution of these factors during this age range?
Are there any gender differences over time and across factors?

How do the interrelationships between individual, behavioural and environmental factors affect BMI?

**Delimitations**

This study involved the use of data collected from birth to age 14 years as part of the Western Australian Pregnancy Cohort (Raine) Study. As a result, this research inherited the limitations of the initial and ongoing data collection processes implemented at the time the data were collected, and for each subsequent follow-up. More specifically related to this research study were the following delimitations.

1. Obesogenic variables available for selection were restricted to those collected in the Raine Study.
2. Time points of data collection limited by the Raine Study, i.e. birth and follow-ups at mean age 1, 2, 3, 6, 8, 10, and 14 years.
3. Selection of variables within the Raine database will be delimited to those classified as individual, behavioural and environmental.
4. Proxy measures will be used as variables e.g. skin folds and BMI for adiposity (waist girth at age 14 years or waist-height ratio); Denver and McCarron Assessment of Neuromuscular Development results for motor competence; pedometer step counts for physical activity levels; television, computer, or screen time for sedentary behaviour (parental report); and parenting scale for parental influence.

**Limitations**

Additional limitations associated with this study included:

1. Raine Study sample may not be representative of the metropolitan Western Australian child population, due to the nature of recruitment.
2. Tracking of some variables changed across follow-ups (e.g. income brackets changed to reflect inflation, physical activity question wording changed).

3. Reliability and validity (psychometric properties) of self-reported measures cannot be established e.g. parent height and weight.

4. Parent reported observational data (i.e. non-standardized surveys or questionnaires) have no reliability or validity measures (psychometric properties).

5. Data were gathered by parent report prior to the age 14 year follow-up, and then changed to a mix of parent and self-report from 14 years.

6. Sample size limited to the original 2,868 infants at birth, and variations in numbers of participants at each consecutive time point.

7. For the following variables the question format and responses collected were not deemed to be interpretable for use in this study:
   - Childcare attendance from birth to age 6 years.
   - Playgroup attendance from birth to age 6 years.
   - Parent planned family activities at 14 years.
   - Pets at home.

8. Lack of diversity in ethnicity variables, small samples within different ethnic groups, with a high skew toward Caucasian. Two groups were created, Caucasian and non-Caucasian, with the latter a composite group of many nationalities, which may mask true effects between ethnic groups.

9. Diet indicator variables chosen were based on intake of fat (10 question composite score), vegetables and fruit. These variables do not provide an accurate indication of complete dietary patterns in this cohort and may account for weak and null findings, particularly in respect to positive associations between diet and obesity in the literature.

10. Adiposity Rebound. Data collection at follow-ups is in years, with the time point being the average age at that assessment. In some follow-ups there was a large range of ages for collection of data. This is particularly significant in respect to the mean BMI trajectories presented, and the calculation of adiposity rebound, although the clear distinction in time
points still provide a valid assessment of the difference between the weight status categories. The Raine Study did not collect data in years four and five and these are important years for adiposity rebound, although this seemed relevant to the overweight and obese group distinctions only. Notably, these results may underestimate the occurrence of adiposity rebound because of this limitation (Chivers et al., 2010).

11. Structural equation modelling (SEM). Although a model was proposed during the concept stage of this current research with SEM in mind, the model was specified after the Raine Study data collection. Therefore there is the likelihood that some key variables (to the current research) have been omitted from the original Raine Study design (Kline, 2005).

12. SEM. An exploratory approach was taken and hence findings reported are only a representation of what was found in this cohort sample, and not necessarily of population behaviour. For this, confirmation with either a hold-out sample (internal replication) or another similar cohort group (external replication) would be necessary (Kline, 2005). However the purpose of SEM in this study was to use these models to diagrammatically articulate the interrelationships occurring in concurrence with other statistical findings.

13. SEM. Only model building was performed using a data set with mean replacement of missing data. This enabled the use of theoretically sound single step model building (adding pathways) using modification indices.

Publications Resulting from this Thesis

Over the course of this research program, aspects from this thesis have been accepted for publication. They are listed below, with full PDF articles attached at Appendix A.


Toddlerhood

“The toddler craves independence, but fears desertion.”

By Dorothy Briggs