

Maternal work hours in early to middle childhood link to later adolescent diet quality

Jianghong Li^{1,2,*}, Therese O'Sullivan^{2,3}, Sarah Johnson^{1,2}, Fiona Stanley² and Wendy Oddy²

¹Curtin Health Innovation Research Institute, Centre for Population Health Research, Curtin University, Perth, Western Australia, Australia: ²Telethon Institute for Child Health Research, Centre for Child Health Research, The University of Western Australia, 100 Roberts Road, Subiaco, Western Australia 6008, Australia:

³School of Exercise and Health Science, Edith Cowan University, Joondalup, Western Australia, Australia

Submitted 11 January 2011: Accepted 25 October 2011: First published online 29 November 2011

Abstract

Objective: Previous studies on maternal work hours and child diet quality have reported conflicting findings possibly due to differences in study design, lack of a comprehensive measure of diet quality and differing ages of the children under investigation. The present study aimed to prospectively examine the impact of parental work hours from age 1 year to age 14 years on adolescent diet quality.

Design: Multivariate linear regression models were used to examine independent associations between parents' work hours at each follow-up and across 14 years and adolescent diet quality at age 14 years. A diet quality index was based on the international literature and Australian recommendations, consisting of six food groups and nine nutrients.

Setting: Perth, Western Australia.

Subjects: Children (*n* 1629) participating in the Western Australian Pregnancy Cohort (Raine) Study.

Results: Compared with children of mothers in full-time employment, children of mothers who were not employed in early childhood up to age 5 years had a higher average diet quality score at age 14 years, independent of maternal and family socio-economic status. Across 14 years the number of years the mother worked full time and increasing average weekly hours were associated with lower diet quality. Father's work hours had little association with adolescent diet quality.

Conclusions: Having a mother stay at home in early to middle childhood is associated with better diet quality in adolescence. Support may be beneficial for families where the mother returns to full-time employment before the child reaches 8 years of age.

Keywords

Maternal employment
Maternal work hours
Father's work
Diet quality
Adolescent
Raine Study

Over the last few decades, the traditional family model of a mother involved in full-time home duties and the father as the breadwinner has changed. In Australia and many Western countries, social and economic changes since the 1980s have resulted in an increased number of mothers in the paid labour force. Between 1984 and 2009, the proportion of Australian mothers with dependant children in paid employment increased from 43% to 63%. Within this 25-year period, the proportion of mothers in couples with young children (0–4 years) in paid employment increased from 30% to 52%; the increase was smaller among lone mothers with young children, from 19% to 27%⁽¹⁾. While mothers' employment or long work hours can increase family income, it may also reduce their capacity to provide adequate time for children to develop healthy eating patterns, an integral part of their development.

Mothers are usually responsible for food shopping and meal preparation⁽²⁾, hence it is important to investigate whether increasing maternal work hours affect the dietary quality of children. Despite a number of previous studies on maternal employment and child nutrition^(3–8), relatively little is known about differences in robust measures of children's dietary quality by parental employment status. Extra household income generated from maternal employment allows the family to afford a wider variety of better-quality groceries and fresh produce, but working mothers may have less time or energy to plan, shop or prepare healthy meals, and as a result more meals may be purchased from restaurants or fast-food outlets^(9–11).

Previous studies investigating parental employment and diet in children and adolescents have reported conflicting results. Some have shown positive associations

*Corresponding author: Email jianghongli@ichr.uwa.edu.au or Jianghong.Li@curtin.edu.au

between maternal employment and nutrition^(3,4,12), others negative^(5,6), and others have shown none^(7,8). This variability may be related to differences in the age of the children under investigation (ages 2 to 18 years), how parents' work was measured (working *v.* not working, part time or full time or long work hours), whether or not potential confounding variables were adjusted for (e.g. parental education and family income), the cross-sectional design^(4,6,7,12) and economic environment (e.g. developed^(5-8,12) *v.* developing countries^(3,4)). Varying methods of assessing dietary quality or pattern may also have contributed to conflicting findings in previous studies. Some have used intake of selected individual nutrients⁽⁴⁾, some meal patterns^(8,13) and others questions investigating dietary habits such as meal skipping or intake of soft drinks^(3,14). Using these types of assessment to measure dietary quality may be limiting as they only consider a small number of nutrients or isolated aspects of the diet. An alternative method is to use a quality index score which represents a broader picture of food and nutrient consumption and thus considers the diet as a whole⁽¹⁵⁾.

Few studies have examined the link between child dietary quality and parental work from a longitudinal perspective^(5,16). It is possible that children develop healthy dietary habits in infancy and early to middle childhood and this development may continue into adolescence. Dietary pattern in adolescence is likely to reflect the early onset of the ongoing development of healthy eating in children. Most previous studies have not examined the potential influence of fathers' work on child diet quality. While mothers often assume the responsibility of food shopping and meal preparation⁽²⁾ and hence have a greater influence on children's diet quality, fathers can also play a role in developing and maintaining healthy diet in the family. Fathers who work part time may be more likely than fathers who work long hours to assist with meal preparation or other housework and child care, so that mothers can devote adequate time for healthy meal provision. Fathers may also take more responsibility for preparing school lunches and after-school snacks, shopping and preparing meals when mothers work full-time hours. Bauer and co-authors⁽¹⁶⁾ have shown that father's employment when the child was in middle school was associated with higher odds of the adolescent consuming fast food in high school but father's concern with healthy eating was associated with lower odds of fast-food intake in high school in the USA.

To date no studies have investigated parental work and adolescent diet prospectively, using a diet quality index. The present study aimed to investigate the association between both mother's and father's involvement in the work force from age 1 year to age 14 years and a dietary quality index measured at age 14 years in a cohort of adolescents in Western Australia, independent of maternal age, race and education, family income, family structure, child gender and the number of siblings.

Methods

Participants

The Western Australian Pregnancy Cohort (Raine) Study recruited 2900 mothers between the 16th and 20th week of gestation from May 1989 to November 1991 and the initial cohort comprised 2868 live births. The study methods are reported elsewhere⁽¹⁷⁾. The Human Ethics Committees at King Edward Memorial Hospital and/or Princess Margaret Hospital for Children in Perth approved all protocols for the study.

In brief, data were collected at ages 1 year and 2, 3, 5, 8, 10 and 14 years (overall response rate of 76%). The 14-year follow-up commenced in 2003, as close to the participants' 14th birthday as possible, and was completed in 2006. Data collection included anthropometry, physical activity, cardiovascular functioning and dietary intake. At 14 years 1860 participants completed all or part of the follow-up, 357 deferred their participation until the next follow-up, 207 were lost to follow-up, 412 withdrew from the Raine Study and thirty-two had died. The current sub-study was based on 1629 (87.6% of 1860) participants who completed an FFQ at the 14-year follow-up.

Diet quality

The adolescents' usual dietary intake over the previous 12 months was assessed with a semi-quantitative FFQ developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) in Adelaide, Australia^(9,10). The FFQ was completed by the primary caregiver in consultation with the study adolescent. Respondents were asked about their usual consumption of 212 food and beverage items, excluding alcohol, and how their usual serving compared with a standard serving size given in household measurements (spoons, cups, slices, etc.). All completed FFQ were checked by a research nurse and missing or unclear responses were clarified when the adolescents attended their physical assessment. The CSIRO entered and verified the FFQ and provided estimates of daily intakes of foods and nutrients using Australian food composition data. This FFQ has been shown to correctly rank a reasonable proportion of most nutrient intakes when compared with a 3 d food record in this cohort⁽¹⁸⁾.

Based on the international literature and Australian recommendations⁽¹⁹⁾, we compiled an index of diet quality consisting of fifteen components including six food groups and nine nutrients. The food groups were: (i) breads, cereals, rice, pasta and noodles; (ii) vegetables; (iii) fruit; (iv) milk, yoghurt and cheese; (v) meat, fish, poultry, eggs, nuts and legumes; and (vi) extra foods (takeaway food, cakes, chips, biscuits, sweets, soft drinks)⁽¹⁹⁾. The nutrients included key nutrients from the respective food groups: (i) vitamin C; (ii) vitamin A (retinol); (iii) dietary fibre; (iv) Fe; (v) Ca; (vi) protein; (vii) total fat as a percentage of total kilojoules; (viii) saturated fat as a percentage of

total kilojoules; and (ix) the *n*-6:*n*-3 fatty acid ratio (omega-6:omega-3). We utilized a scoring system based on the *Australian Guide to Healthy Eating*⁽¹⁹⁾ and *Nutrient Reference Values for Australia and New Zealand*⁽²⁰⁾. The maximum score was 150 being indicative of the highest dietary quality whereas the minimum score was 20 indicative of the lowest dietary quality.

Parental work

Data on mother's working hours were collected at all follow-ups and coded as not working, working 1–15 h, 16–24 h, 25–34 h or ≥ 35 h (full time) weekly. Father's work hour data were collected at ages 5, 8, 10 and 14 years, and coded as not working, working 1–34 h, 35–44 h, 45–54 h or ≥ 55 h weekly. At ages 1, 2 and 3 years, only father's employment status was collected (employed or not). Further, joint employment in couple families was analysed from age 1 year to age 14 years and coded as: (i) neither parent working; (ii) mother working part time or full time/father not working; (iii) mother working full time/father working; (iv) mother working part time/father working; or (v) mother not working/father working. To examine the overall effects of both parents' work hours during the entire period and at five stages of development (from age 1 year to ages 3, 5, 8, 10 and 14 years), we constructed three sets of continuous variables: (i) the average hours the mother worked per week; (ii) the number of years the mother worked full time and part time; and (iii) the average of hours and the number of years the father worked for ≥ 45 h weekly (from ages 5 to 14 years due to lack of data on father's working hours in the first three years).

Potential confounders

Parental education^(6,21), particularly mother's education^(22–24), family income^(25–27), maternal age⁽²²⁾ and ethnicity/race⁽¹⁶⁾ have been linked to children's diet quality and these factors are also associated with parental employment status and work patterns. To control for these potential confounders, we included in the subsequent multivariate analyses: maternal age at pregnancy (<20, 20–24, 25–29, 30–34, ≥ 35 years), maternal race (Caucasian or other), mother's education (primary schooling only, trade certificate/other qualification, college diploma, professional degree, university degree), family structure (couple–both biological parents, couple–step parent, lone parent) at each follow-up and combined annual family income at age 14 years (<\$AUD 25 000, \$AUD 25 000–35 000, \$AUD 35 001–50 000, \$AUD 50 001–70 000, \$AUD 70 001–140 000, >\$AUD 140 000). We also adjusted the analyses for child gender and the number of siblings in the household at the time of pregnancy.

Analysis

The diet quality index in adolescence at age 14 years was examined, using cross-sectional information on parental

work at age 14 years and longitudinal data on parental work prior to age 14 years (from age 1 to 3 years, ages 5, 8 and 10 years) in a series of multivariate regression models. We first analysed all types of families using only mother's work hours as the main independent variables. We then examined father's and mother's work hours simultaneously in two-parent families, including couple families with a step parent. Parents' work hours were analysed as categorical rather than continuous variables to differentiate various part-time or full-time working hours. We conducted the *F* test for overall differences with four degrees of freedom, as well as tests for differences between categories of work hours in the diet quality index at age 14 years. In a further step we examined the cumulative effects of mother's and father's work hours on adolescent diet quality at age 14 years, using the average work hours across the follow-ups, the number of years the mother worked full time or part time, and the father worked extended hours, as described above. Analyses were accomplished using multivariate general linear regression models in the SPSS statistical software package version 16 (SPSS Inc., Chicago, IL, USA). A *P* value of ≤ 0.05 was considered as statistically significant.

Results

Table 1 shows the frequency distribution of the diet quality index in 1629 adolescents for whom the dietary data were collected at age 14 years. The index score has a near normal distribution, with a mean of 76.1, a standard deviation of 15.51, a minimum and a maximum score of 20 and 120 respectively (Table 1). Thus a linear regression model was appropriate for analysing the diet quality index as the outcome variable. Table 1 also shows the maternal and family socio-economic characteristics of the study population.

At ages 1 and 2 years, between 64.8% and 67.0% of mothers in all families were not working but this proportion began to decrease from age 3 years onwards, to only 23.3% by age 14 years (Table 2). The percentage of mothers who worked full time (≥ 35 h weekly) increased from 7.9% at age 1 year to 25.1% at age 14 years. Independent of maternal age, race, education, family income, family structure, child gender and number of siblings, there was a significant overall association between mother's work hours when the child was aged 1 year and the diet quality score at age 14 years. Compared with children whose mothers worked full time, those children whose mothers either did not work or worked only part time had a higher average diet quality index score, with a difference ranging from 4.76 to 9.55 points. At ages 2, 3 and 5 years, there remained a significant global association between maternal work hours and diet quality as indicated in the *F*-test statistics. More specifically, having a mother not working, compared with working full time, continued to be positively associated with the diet quality score at age 14 years, with the effect size declining at age 5 years.

Table 1 Maternal and family socio-economic and demographic characteristics of the study population (*n* 1629)*, the Western Australian Pregnancy Cohort (Raine) Study

Variable name	<i>n</i>	%	Mean	SD	Min	Max
Diet quality index score†			76.08	15.51	20	120
Maternal age at birth (years)						
<20	100	6.1				
20–24	284	17.4				
25–29	488	30.0				
30–34	480	29.5				
≥35	256	15.7				
Maternal race						
Caucasian	1464	89.9				
Other	144	8.9				
Mother's education in pregnancy						
Primary schooling	733	45.0				
Trade/other	223	13.7				
College diploma	298	18.3				
Professional registration/University degree	375	23.0				
Mother's education at age 8 years						
Primary schooling	638	39.2				
Trade/other	59	3.6				
College diploma	482	29.6				
Professional registration/University degree	365	22.4				
Family structure at age 14 years						
Couple—both biological parents	1060	65.1				
Couple—step parent	205	12.6				
Lone parent	357	21.9				
Combined annual family income at age 14 years (\$AUD)						
<25 000	295	18.1				
25 000–35 000	165	10.1				
35 001–50 000	327	20.1				
50 001–70 000	271	16.6				
70 001–140 000	227	13.9				
>140 000	289	17.7				
Child gender (male)	834	51.3				
Number of siblings in pregnancy						
0	792	48.6				
1	495	30.4				
≥2	341	20.9				

*Missing cases: maternal age and race (1.3%), maternal education measured in pregnancy (0%), maternal education at age 8 years (5.2%), family structure (0.4%), family income at age 14 years (3.4%), child gender (0.1%).

†A higher index score represents a better diet quality.

At ages 8 and 14 years, there was no significant overall association between mother's working hours and adolescent diet quality. There was a significant global association between mother's work hours at age 10 years and adolescent diet quality at age 14 years: adolescents whose parents worked a low number of hours (<25 h/week) had better diet quality than those whose parents worked full time. However, when mothers worked a moderate number of hours (25–34 h/week), the diet quality was worse, compared with when mothers worked full time.

We observed a similar pattern with maternal employment when father's employment status and work hours were included in the analysis (Table 3). There was a significant global association between mother's working hours (at ages 1, 2 and 3 years) and the diet quality score at age 14 years. Adolescents whose mothers did not work in the first three years of the child's life had a higher than average diet quality score, compared with those whose mothers worked full time in these years. Mother's part-time hours when her child was aged 1 year and short working hours (1–15 h weekly) at age 3 years were also

significantly associated with a higher mean diet quality score. From age 5 years onwards, there was no longer a significant global association between mother's working hours and diet quality, and the effect size for not working as indicated by the β coefficient declined steadily.

In contrast, father's employment status and work hours had no significant effect on adolescent diet quality in any follow-ups, as indicated by the *P* values for the global *F* tests. The increment in the R^2 when father's work hours were added to the model was small, ranging from an increase of 1.8% to 13.7%.

We observed significant global associations between joint parental employment status when the child was 1, 2 and 3 years old and the diet quality scores at age 14 years (Table 4). Having a mother not working with a father working was associated with a higher average diet quality score at age 14 years, compared with when the mother worked full time and the father worked. Maternal part-time work with the father working at age 1 year and age 3 years was also beneficial for diet quality at age 14 years. However, from age 5 to 10 years, there was no longer a

Table 2 Independent association between maternal working hours and diet quality at 14 years of age: all families (*n* 1212 to 1452)*, the Western Australian Pregnancy Cohort (Raine) Study

Mother's work hours (weekly)	<i>n</i>	%	β †	<i>P</i> value	<i>F</i> test (df = 4)‡	95% CI	
						Lower	Upper
Age 1 year							
Not working	985	64.8	5.33	0.001	<i>P</i> = 0.002	2.32	8.33
1–15 h	225	14.8	4.80	0.007	<i>F</i> = 4.23	1.34	8.26
16–24 h	139	9.2	4.76	0.01		0.96	8.55
25–34 h	50	3.3	9.55	<0.001		4.38	14.71
≥35 h (ref.)	120	7.9					
Age 2 years							
Not working	842	67.0	4.47	0.008	<i>P</i> = 0.01	1.16	7.79
1–15 h	173	13.8	2.28	0.25	<i>F</i> = 3.31	–1.58	6.15
16–24 h	113	9.0	0.96	0.65		–3.32	5.15
25–34 h	32	2.5	–0.31	0.92		–6.51	5.90
≥35 h (ref.)	97	7.7					
Age 3 years							
Not working	889	62.3	5.81	<0.001	<i>P</i> < 0.001	2.80	8.83
1–15 h	206	14.4	2.77	0.12	<i>F</i> = 5.60	–0.73	6.27
16–24 h	142	10.0	2.56	0.18		–1.22	6.34
25–34 h	71	5.0	1.25	0.59		–3.29	5.80
≥35 h (ref.)	119	8.3					
Age 5 years							
Not working	761	50.9	2.63	0.05	<i>P</i> = 0.01	0.05	5.20
1–15 h	221	14.8	3.48	0.03	<i>F</i> = 3.14	0.42	6.54
16–24 h	209	14.0	–0.65	0.68		–3.76	2.45
25–34 h	120	8.0	0.70	0.71		–2.92	4.31
≥35 h (ref.)	184	12.3					
Age 8 years							
Not working	658	44.2	2.78		<i>P</i> = 0.13	0.29	5.28
1–15 h	234	15.7	3.32		<i>F</i> = 1.79	0.36	6.28
16–24 h	223	15.0	1.27			–1.70	4.24
25–34 h	165	11.1	3.00			–0.21	6.21
≥35 h (ref.)	210	14.1					
Age 10 years							
Not working	490	32.6	2.17	0.09	<i>P</i> = 0.03	–0.32	4.69
1–15 h	279	18.6	2.06	0.14	<i>F</i> = 2.61	–0.68	4.80
16–24 h	260	17.3	2.03	0.15		–0.75	4.81
25–34 h	218	14.5	–1.46	0.33		–4.36	1.44
≥35 h (ref.)	257	17.1					
Age 14 years							
Not working	366	23.3	1.27		<i>P</i> = 0.11	–1.18	3.72
1–15 h	247	15.7	3.30		<i>F</i> = 1.90	0.70	5.90
16–24 h	268	17.1	2.45			–0.02	4.92
25–34 h	294	18.7	1.17			–1.23	3.56
≥35 h (ref.)	394	25.1					

ref., referent category.

*All models adjusted for mother's age, education and race, family income at age 14 years, age-specific family structure, child gender and number of siblings. Mother's education at age 8 years was adjusted for at ages 8, 10 and 14 years.

†Difference in the mean of diet quality score between a category of work hours and the reference group. A higher index score represents a better quality diet.

‡The global *F*-test statistics for overall differences in diet quality index associated with mother's work hours.

significant overall association between joint parental employment and the diet quality score at age 14 years, and the β coefficients for the four categories of joint employment indicated a general decline in the effect size.

At age 14 years, there was a significant overall association between joint employment and the diet quality score and this was mainly reflected in a higher average diet quality score when neither parent worked, compared with the reference group. Having neither parent working in the first three years of the child's life was also associated with a better adolescent diet. However, at any age, when a mother worked but the father did not, there was no improvement in the diet quality score.

Table 5 presents the long-term association between mother's and father's working hours during the growth of the child and adolescent diet quality, independent of maternal age, race and education, family structure, family income, child gender and the number of siblings. The average working hours weekly and the number of years for which the mother worked full time were negatively associated with adolescent diet quality and this association appeared to be stronger in the first eight years of the child's life. Mother's cumulative hours spent in part-time work had no significant effect on the outcome variable. Consistent with the results from Tables 2 to 4, the number of years the father worked for ≥ 45 h weekly and the

Table 3 Independent association between mother's and father's work hours and diet quality at 14 years of age: both-parent families (*n* 1073 to 1295)*, the Western Australian Pregnancy Cohort (Raine) Study

Mother's work hours (weekly)	Diet quality index										
	%†	β‡	<i>P</i> value (df = 4)	95% CI		Father's work hours (weekly)	%	β	<i>P</i> value	95% CI	
				Lower	Upper					Lower	Upper
Age 1 year			0.005§								
Not working	63.1	5.58	0.001	2.37	8.79	Not working	14.6	0.96	0.47§	-1.54	3.35
1-15 h	15.7	4.76	0.01	1.11	8.42	Working	85.4	ref.			
16-24 h	10.0	5.48	0.007	1.52	9.44						
25-34 h	3.4	8.90	0.001	3.46	14.33						
Age 2 years			0.01§								
Not working	65.7	5.15	0.004	1.63	8.68	Not working	10.9	0.65	0.67§	2.28	3.57
1-15 h	14.6	3.12	0.13	-0.96	7.20	Working	89.1	ref.			
16-24 h	9.6	1.55	0.49	-2.84	5.95						
25-34 h	2.5	1.04	0.76	-5.62	7.70						
Age 3 years			<0.001§								
Not working	61.8	6.57	<0.001	3.22	9.93	Not working	9.7	-0.90	0.55§	-3.89	2.09
1-15 h	15.0	4.00	0.04	0.15	7.85	Working	90.3	ref.			
16-24 h	10.4	2.94	0.17	-1.21	7.08						
25-34 h	5.0	2.13	0.41	-2.88	7.15						
Age 5 years			0.07§						0.78§		
Not working	49.3	3.12		0.17	6.07	Not working¶	9.5	1.17		-2.54	4.87
1-15 h	15.1	3.60		0.14	7.06	1-34 h	5.0	1.30		-3.44	6.03
16-24 h	15.2	0.29		-3.18	3.75	35-44 h	42.9	-0.51		-3.02	2.01
25-34 h	8.3	1.51		-2.60	5.63	45-54 h	23.4	0.55		-2.23	3.32
Age 8 years			0.18§						0.50§		
Not working	42.8	2.93		0.05	5.80	Not working	8.8	0.81		-3.00	4.60
1-15 h	16.5	3.27		-0.03	6.58	1-34 h	6.0	2.08		-2.14	6.30
16-24 h	16.5	0.92		-2.40	4.24	35-44 h	41.8	-0.94		-3.38	1.50
25-34 h	11.1	2.52		-1.14	6.18	45-54 h	22.9	-1.01		-3.71	1.70
Age 10 years			0.07§						0.08§		
Not working	30.2	1.24		-1.64	4.13	Not working	6.8	3.16		-1.24	7.57
1-15 h	19.1	2.44		-0.64	5.52	1-34 h	8.6	3.98		-0.04	7.93
16-24 h	18.6	1.71		-1.36	4.78	35-44 h	40.4	-0.59		-3.25	2.07
25-34 h	14.9	-1.89		-5.14	1.36	45-54 h	26.9	0.56		-2.25	3.37
Age 14 years			0.30§						0.82§		
Not working	22.8	0.43		-2.34	3.20	Not working	7.0	0.59		-3.85	5.03
1-15 h	15.4	2.62		-0.37	5.61	1-34 h	8.4	-1.06		-4.81	2.70
16-24 h	18.0	1.97		-0.81	4.74	35-44 h	42.0	-0.95		-3.49	1.59
25-34 h	19.2	0.09		-2.62	2.79	45-54 h	24.1	0.12		-2.63	2.86

ref., referent category.

*Separate models were run for each year and all models adjusted for mother's age, education and race, family income at age 14 years, child gender and number of siblings. Mother's and father's/partner's work hours were analysed simultaneously in each model.

†Reference group for mother's work hours: ≥ 35 h weekly.

‡Difference in the mean diet quality score between a category of work hours and the reference group. A higher index score represents a better quality diet.

§*P* value for the global *F* test for overall differences in diet quality index associated with mother's (df = 4) and father's work hours (df = 1 or 4). The *F* statistic for mother's work hour categories ranged from 1.23 at age 14 years to 5.27 at age 3 years, and for father's work hour categories it ranged from 0.19 at age 2 years to 2.11 at age 10 years.

||Father's work hours were not available at ages 1, 2 and 3 years.

¶Reference group for father's work hours: ≥ 55 h weekly.

average hours he worked per week had no significant effect on adolescent diet quality at age 14 years.

Discussion

Our findings suggest that mother's employment status and work hours in the first three to five years of her child's life are linked with diet quality in adolescence. In all families, adolescents whose mothers did not work during the first five years of their life on average had higher diet quality at age 14 years, compared with those whose mothers worked full time during these early years. Similarly, in two-parent families, having a mother staying home at age 1 year to age 3 years, compared with full-time work, was positively

associated with an increase in the mean diet quality score at age 14 years. However, this association diminished after age 5 years. This held true regardless of whether we examined the mother's and father's work hours as separate or joint employment variables. Our further analysis aimed at estimating the overall effects demonstrated that maternal full-time work and the average weekly hours a mother worked in the first eight years of her child's life were more strongly associated with a decrease in the diet quality score at age 14 years. Taking all our findings together, it was maternal work hours during early to middle childhood that may have an important impact on adolescent diet quality.

Despite that the age-specific analysis showed a positive association between mother's part-time work at some

Table 4 Independent association between joint parental work and diet quality at 14 years of age: both-parent families (*n* 1079 to 1294), the Western Australian Pregnancy Cohort (Raine) Study

Joint parental work status	<i>n</i>	%	β †	<i>P</i> value	<i>F</i> test (df = 4)‡	Diet quality index*	
						Lower	Upper
Age 1 year							
Mother PT or FT/father not working	45	3.3	3.92	0.16	<i>P</i> = 0.01	-1.56	9.40
Neither parent working	148	11.0	7.32	0.001	<i>F</i> = 3.60	3.18	11.47
Mother PT/father working	357	26.6	5.98	0.001		2.45	9.51
Mother not working/father working	700	52.1	5.74	0.001		2.35	9.12
Mother FT/father working (ref.)	94	7.0					
Age 2 years							
Mother PT or FT/father not working	22	2.0	-0.12	0.98	<i>P</i> = 0.01	-7.75	7.51
Neither parent working	105	9.5	6.00	0.01	<i>F</i> = 3.17	-1.37	10.61
Mother PT/father working	281	25.3	1.68	0.40		-2.20	5.56
Mother not working/father working	624	56.2	4.35	0.02		0.60	8.02
Mother FT/father working (ref.)	78	7.0					
Age 3 years							
Mother PT or FT/father not working	26	2.1	-1.66	0.63	<i>P</i> < 0.001	-8.45	5.12
Neither parent working	100	8.1	6.72	0.004	<i>F</i> = 5.68	2.11	11.33
Mother PT/father working	355	28.9	3.75	0.04		0.11	7.40
Mother not working/father working	661	53.8	6.55	<0.001		3.05	10.05
Mother FT/father working (ref.)	87	7.1					
Age 5 years							
Mother PT or FT/father not working	38	3.1	4.58		<i>P</i> = 0.17	-1.11	10.26
Neither parent working	76	6.2	3.67		<i>F</i> = 1.60	-0.97	8.31
Mother PT/father working	453	36.8	2.30			-0.75	5.34
Mother not working/father working	529	43.0	3.59			0.57	6.61
Mother FT/father working (ref.)	134	10.9					
Age 8 years							
Mother PT or FT/father not working	40	3.3	2.88		<i>P</i> = 0.26	-2.62	8.37
Neither parent working	62	5.1	4.69		<i>F</i> = 1.33	-0.10	9.47
Mother PT/father working	511	42.0	2.72			-0.15	5.60
Mother not working/father working	458	37.6	2.96			0.04	5.89
Mother FT/father working (ref.)	146	12.0					
Age 10 years							
Mother PT or FT/father not working	39	3.2	0.96		<i>P</i> = 0.58	-4.78	6.71
Neither parent working	41	3.4	4.83		<i>F</i> = 0.72	-0.84	10.50
Mother PT/father working	617	51.1	0.77			-1.87	3.40
Mother not working/father working	322	26.7	0.62			-2.32	3.57
Mother FT/father working (ref.)	188	15.6					
Age 14 years							
Mother PT or FT/father not working	50	4.0	-2.84	0.28	<i>P</i> = 0.02	-7.94	2.26
Neither parent working	38	3.0	7.80	0.02	<i>F</i> = 3.03	1.54	14.05
Mother PT/father working	638	50.9	1.44	0.21		-0.81	3.70
Mother not working/father working	247	19.7	-0.60	0.68		-3.45	2.25
Mother FT/father working (ref.)	280	22.3					

PT, part time; FT, full time; ref., referent category.

*All models adjusted for mother's age, education and race, family income at age 14 years, child gender and number of siblings.

†Difference in the mean diet quality score between a category of work hours and the reference group. A higher index score represents a better quality diet.

‡Test statistics for overall differences in diet quality index associated with joint work status.

follow-ups and diet quality at age 14 years, the analysis of the overall effects of part-time employment on the outcome variable showed no statistical significance.

In contrast to the results found with the mother staying at home, father's employment status or work hours was not significantly associated with adolescent diet quality. The results from the analysis of joint employment showed no significant difference in child diet quality when the father stayed at home while the mother was working either part time or full time. This finding is consistent with previous research that mothers are mainly responsible for household work, including meal provision, even when they participate in the labour force^(2,28,29).

Our study has shown that when neither the mother nor the father worked when the child was 1 to 3 years of age, the diet quality in adolescence was higher than when both parents worked during these years. It is plausible that when no parent works, the mother has more time to plan and prepare healthy meals for the family especially if the father assists with child care and other housework.

The presence of a second child in the family was found to be associated with a decrease in the average diet quality score in the age-specific analyses that included both-parent families only and also in analysis of cumulative effects of mothers working full time on adolescent diet quality at

Table 5 Overall association between parental working hours since child's birth and diet quality at 14 years of age ($n = 876\text{--}1016$)*, the Western Australian Pregnancy Cohort (Raine) Study

	Diet quality index				
	Mean	β †	P value	95% CI	
				Lower	Upper
Mother's work hours					
Average hours worked weekly					
First three years	6.7	-0.21	<0.001	-0.31	-0.12
First five years	7.8	-0.22	<0.001	-0.32	-0.13
First eight years	8.7	-0.20	<0.001	-0.30	-0.09
First ten years	10.0	-0.18	0.001	-0.29	-0.07
From age 1 year to age 14 years	11.6	-0.17	0.003	-0.027	-0.07
Number of years worked full time					
First three years	0.2	-2.94	<0.001	-4.41	-1.46
First five years	0.3	-2.15	<0.001	-3.16	-0.95
First eight years	0.4	-1.45	0.006	-2.49	-0.42
First ten years	0.6	-0.82	0.07	-1.70	-0.06
From age 1 year to age 14 years	0.8	-0.82	0.03	-1.56	-0.08
Number of years worked part time					
First three years	0.8	-0.75	0.10	-1.64	-0.13
First five years	1.2	-0.62	0.09	-1.35	-0.11
First eight years	1.6	-0.52	0.10	-1.15	-0.10
First ten years	2.2	-0.55	0.06	-1.11	-0.01
From age 1 year to age 14 years	2.7	-0.26	0.33	-0.77	0.26
Father's work hours					
Number of years worked ≥ 45 h weekly (from ages 5 to 14 years)	1.8	0.29	0.49	-0.48	0.99
Average hours worked weekly from ages 5 to 14 years	42.3	-0.03	0.53	-0.12	0.06

*All multivariate models were based on cases with no missing data at each respective follow-up point, included all families and adjusted for mother's age, education and race, family income and family structure at age 14 years, child gender and number of siblings. Mother's education at age 8 years was adjusted for at ages 8, 10 and 14 years.

†Change in the mean diet quality score with an increment in average hours or years worked. A higher index score represents a better quality diet.

age 14 years: the magnitude of effect ranged from $b = -1.92$ to $b = -3.14$ ($P = 0.052$ to $P = 0.006$). However, the adjustment of this factor did not alter the effect of mother's and father's work hours on the outcome variable.

Previous studies, mostly cross-sectional in nature, have reported conflicting results about associations between maternal employment and adolescent diet quality^(8,11,30–34). By examining the relationship between parental employment status and weekly working hours prospectively, our age-specific analysis has revealed that having mothers stay home in the first three to five years of life was beneficial to their child's diet quality in adolescence. Based on our observations, healthy eating in children begins early in life and takes time to develop. This may be because children need to develop a taste early for healthy food and learn to conform to parental preferences and requirements for healthy eating habits. Once a pattern of healthy diet is established in the family, it may well continue through to adolescence and adulthood. It may require parental time and energy to develop healthy eating patterns early and to maintain them through childhood. Our study has relevance for future research on maternal work and other health-related behaviours which may also begin early in life and develop over time, including physical activity and risk-taking behaviours.

Strengths and limitations

The present study has several strengths. It is a prospective study of parental work and adolescent diet quality using

longitudinal information on the predictor measured at various ages of a child's development, with a large cohort size. It systematically examined the possible effect of father's employment status and work hours on adolescent diet quality. The study adjusted for important confounders. However, the study also has some limitations. Due to the lack of information on child diet prior to age 14 years we were unable to investigate whether or not and to what extent diet quality in early and mid childhood is associated with diet quality in adolescence. This link would facilitate a better understanding of our finding that maternal work hours in early to middle childhood but not at later ages influence adolescent diet quality at age 14 years. Further, while our measure of diet quality was based on the dietary intake jointly reported by the primary caregiver and the adolescent, it would be important for future research in this field to utilize self-reported dietary intake by adolescents themselves.

Policy implications

The percentage of working women with children under 5 years of age has increased over the last two decades⁽¹⁾. Given the benefit of having a mother stay at home in early to middle childhood for later adolescent diet quality, support is needed for families where the mother returns to full-time employment before the child reaches 8 years of age. Implementation of healthy eating guidelines and provision of healthy food at child-care centres, pre-schools

and schools are one way of helping children of working mothers develop healthy eating habits early. Governmental incentives for food industries to be innovative in producing healthy food products that are affordable, meet nutritional requirements but require less time to prepare would be another way of supporting working mothers, fathers and their children.

Acknowledgements

Sources of funding: The Raine Study is supported by the National Health and Medical Research Council (NH&MRC) of Australia and the Telethon Institute for Child Health Research. Funding for Core Management of the Raine Study is provided by the University of Western Australia (UWA), the Telethon Institute for Child Health Research, the Raine Medical Research Foundation, the UWA Faculty of Medicine, Dentistry and Health Sciences, and the Women and Infants Research Foundation. J.L. is supported by the Curtin University Research Fellowship Scheme and the NH&MRC Program Grant (#572742). W.O. was supported by an NH&MRC Career Development Award. T.O. was supported by the Heart Foundation Beyond Blue Strategic Research Initiative. S.J. is supported by a research grant from the Foundation for Children. *Conflict of interest declaration:* The authors declare that they have no conflict of interest. *Authors' contributions:* J.L. was responsible for the conception, analysis and the writing of the manuscript. T.O. contributed to the review of the literature and the interpretation of the findings. W.O. was responsible for developing the diet quality index and contributed to the interpretation of the results. S.J. contributed to the analysis, the review of the literature and the interpretation of the results. F.S. contributed to the study design and the interpretation of the results. All authors provided substantive comments on various drafts of the manuscript. *Acknowledgements:* The authors gratefully acknowledge the Raine Study participants and their families for their participation in the study; the Raine Study Team for cohort co-ordination and data collection.

References

- Hayes A, Weston R, Qu L *et al.* (2010) *Families Then and Now, 1980–2010 (Factsheet)*. Melbourne: Australian Institute of Family Studies; available at <http://www.aifs.gov.au/institute/pubs/factsheet/fs2010conf/fs2010conf.pdf>
- Lake AA, Hyland RM, Mathers JC *et al.* (2006) Food shopping and preparation among the 30-somethings: whose job is it? (The ASH30 study). *Br Food J* **108**, 475–486.
- Soyer M, Ergin I & GURSOY S (2008) Effects of social determinants on food choice and skipping meals among Turkish adolescents. *Asia Pac J Clin Nutr* **17**, 208–215.
- Tucker K & Sanjur D (1988) Maternal employment and child nutrition in Panama. *Soc Sci Med* **26**, 605–612.
- Hawkins S, Cole T & Law C (2009) Examining the relationship between maternal employment and health behaviours in 5-year-old British children. *J Epidemiol Community Health* **63**, 999–1004.
- Neumark-Sztainer D, Hannan PJ, Story M *et al.* (2003) Family meal patterns: associations with sociodemographic characteristics and improved dietary intake among adolescents. *J Am Diet Assoc* **103**, 317–322.
- Johnson RK, Smiciklas-Wright H, Crouter AC *et al.* (1992) Maternal employment and the quality of young children's diets: empirical evidence based on the 1987–1988 Nationwide Food Consumption Survey. *Pediatrics* **90**, 245–249.
- Siega-Riz AM, Carson T & Popkin B (1998) Three squares or mostly snacks – what do teens really eat?: a sociodemographic study of meal patterns. *J Adolesc Health* **22**, 29–36.
- Baghurst KI & Record SJ (1983) Intake and sources in selected Australian subpopulations of dietary constituents implicated in the etiology of chronic diseases. *J Food Nutr* **40**, 1–15.
- Baghurst KI & Record SJ (1984) A computerised dietary analysis system for use with diaries or food frequency questionnaires. *Community Health Stud* **8**, 11–18.
- Fertig A, Glomm G & Tchernis R (2009) The connection between maternal employment and childhood obesity: inspecting the mechanisms. *Rev Econ Houseb* **7**, 227–255.
- Sweeting H & West P (2005) Dietary habits and children's family lives. *J Hum Nutr Diet* **18**, 93–97.
- Lindholm BW, Touliatos J & Wenberg MF (1984) Predicting changes in nutrition knowledge and dietary quality in ten- to thirteen-year-olds following a nutrition education program. *Adolescence* **19**, 367–375.
- Johansen A, Rasmussen S & Madsen M (2006) Health behaviour among adolescents in Denmark: influence of school class and individual risk factors. *Scand J Public Health* **34**, 32–40.
- Hu FB (2002) Dietary pattern analysis: a new direction in nutritional epidemiology. *Curr Opin Lipidol* **13**, 3–9.
- Bauer KW, Larson NI, Nelson MC *et al.* (2009) Socio-environmental, personal and behavioural predictors of fast-food intake among adolescents. *Public Health Nutr* **12**, 1767–1774.
- Newnham JP, Evans SF, Michael CA *et al.* (1993) Effects of frequent ultrasound during pregnancy: a randomised controlled trial. *Lancet* **342**, 887–891.
- Ambrosini GL, de Klerk NH, O'Sullivan TA *et al.* (2009) The reliability of a food frequency questionnaire for use among adolescents. *Eur J Clin Nutr* **63**, 1251–1259.
- Smith A, Kellett E & Schmerlaib Y (1998) *The Australian Guide to Healthy Eating*. Canberra: Commonwealth of Australia.
- National Health and Medical Research Council (2006) *Nutrient Reference Values for Australia and New Zealand*. Canberra: Commonwealth of Australia.
- Videon TM & Manning CK (2003) Influences on adolescent eating patterns: the importance of family meals. *J Adolesc Health* **32**, 365–373.
- North K & Emmett P (2000) Multivariate analysis of diet among three-year-old children and associations with socio-demographic characteristics. *Eur J Clin Nutr* **54**, 73–80.
- Giskes K, van Lenthe F, Brug HJ *et al.* (2004) Dietary intakes of adults in the Netherlands by childhood and adulthood socioeconomic position. *Eur J Clin Nutr* **58**, 871–880.
- Mullie P, Clarys P, Ridder DD *et al.* (2006) Breakfast frequency and fruit and vegetable consumption in Belgian adolescents. A cross-sectional study. *Nutr Food Sci* **36**, 315–326.
- Milligan RAK, Burke V, Beilin LJ *et al.* (1998) Influence of gender and socio-economic status on dietary patterns and nutrient intakes in 18-year-old Australians. *Aust N Z J Public Health* **22**, 485–493.
- Giskes KK, Turrell GG, Patterson CC *et al.* (2002) Socio-economic differences in fruit and vegetable consumption

- among Australian adolescents and adults. *Public Health Nutr* **5**, 663–669.
27. Kranz S (2006) Meeting the dietary reference intakes for fiber: sociodemographic characteristics of preschoolers with high fiber intakes. *Am J Public Health* **96**, 1538–1541.
 28. Backman D, Haddad E, Lee J *et al.* (2002) Psychosocial predictors of healthful dietary behavior in adolescents. *J Nutr Educ Behav* **34**, 184–192.
 29. Bond S & Sales J (2001) Household work in the UK: an analysis of the British Household Panel Survey 1994. *Work Employ Soc* **15**, 233–250.
 30. French SA (2001) Fast food restaurant use among adolescents: associations with nutrient intake, food choices and behavioral and psychosocial variables. *Int J Obes Relat Metab Disord* **25**, 1823–1833.
 31. Johansen A, Rasmussen S & Madsen M (2006) Health behaviour among adolescents in Denmark: influence of school class and individual risk factors. *Scand J Public Health* **34**, 32–40.
 32. Larson NI, Story M, Eisenberg ME *et al.* (2006) Food preparation and purchasing roles among adolescents: associations with sociodemographic characteristics and diet quality. *J Am Diet Assoc* **106**, 211–218.
 33. Skinner JD, Ezell JM, Salvetti NN *et al.* (1985) Relationships between mothers' employment and nutritional quality of adolescents' diets. *Fam Consum Sci Res J* **13**, 218–225.
 34. Würbach A, Zellner K & Kromeyer-Hauschild K (2009) Meal patterns among children and adolescents and their associations with weight status and parental characteristics. *Public Health Nutr* **12**, 1115–1121.