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Pacific Islands Families: Child And Parental Physical Activity and Body Size—design and methodology

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Abstract

Aim To objectively assess physical activity (PA) and body size in 6-year-old children and their mothers participating in the Pacific Islands Families (PIF) cohort study, and to identify factors potentially related to PA and body size in Pacific children.

Methods The PIF cohort was drawn from live births at Middlemore Hospital (South Auckland, New Zealand) in 2000. Information has been collected at birth, 6 weeks, 12 and 24 months, and 4 and 6 years postpartum. At 6 years, the Child and Parental Physical Activity and Body Size (PIF:PAC) study was simultaneously conducted and measures of child and mother PA (8-day accelerometry), body size (waist circumference, body mass index), and PA supports and barriers (questionnaire) taken.

Results 254 mothers and their children took part in the PIF:PAC study. Usable accelerometer data were gathered for 173 mothers and 200 children over an average of 3–4 days. High levels of overweight and obesity were found in boys, girls, and mothers (62%, 58%, and 97% overweight or obese, respectively).

Conclusion Strategies for obesity reduction in Pacific populations are urgently required. Combined, the PIF and PIF:PAC studies will provide vital information for understanding and targeting the obesity epidemic in Pacific children.

New Zealand's Pacific population continues to be one of the fastest growing and significant ethnic groups in New Zealand,[1] with approximately 6.9% residents identifying as being of Pacific descent.[2] Yet, Pacific peoples residing in New Zealand also continue to be socially disadvantaged relative to other New Zealanders.[3]

Findings from the National Children's Nutrition Survey and 2006/07 New Zealand Health Survey (NZHS) showed that approximately 55-60% of Pacific children are overweight or obese; substantially higher than other New Zealand children.[4,5]

These statistics have immediate negative implications for child health including increased risk of exhibiting type 2 diabetes, risk factors for cardiovascular disease, experiencing obstructive sleep apnoea, orthopaedic complications, a reduced quality of life, and negative psychosocial effects stemming from discrimination and preoccupation with weight.[6–8] Further, obesity in childhood is associated with significant long-term developmental consequences, including an increased risk of exhibiting overweight/obesity and associated morbidities in later life.[9]

Obesity is predominantly the result of an "energy gap", the excess of energy intake over energy expenditure.[10] These energy gaps can be relatively small (e.g. ~20–30 kcal/day), and therefore could be easily reduced by small increases in physical activity (PA).

Participation in regular PA is fundamental to obesity prevention and treatment in children.[11] PA also confers other important benefits in children, including improved bone health[12] and cognitive function,[13] a decreased risk of developing type 2 diabetes,[14,15] and a reduced risk of exhibiting cardiovascular disease risk factors.[16]

Conversely, physical inactivity (often quantified using television or screen time) is associated with a multitude of both short-term and long-term negative health outcomes.[17-19] Consequently, PA promotion for obesity prevention in Pacific children is a public health priority in New Zealand. The *Healthy Eating – Healthy Action* strategy highlighted children and young people, as well as Pacific peoples, as two groups that will achieve the greatest benefits from participating in more PA, and the strategy calls for research to address physical in/activity and obesity in Pacific peoples.[20]

Nationwide assessment of children's PA levels to date has been conducted using self-report, or parental proxy-report measures only, both of which are inherently biased.[21] Notwithstanding this, it appears that Pacific children may actually be more physically active than their European and Māori counterparts, but at increased risk of developing obesity and other lifestyle related diseases due to increased participation in sedentary pursuits such as television watching.[4]

Culturally appropriate, effective, and integrated programmes are urgently required at national and community levels to combat the rising problem of obesity, and to promote healthy lifestyles and well-being for Pacific children and families. Accurate quantification of even small changes in PA and sedentary behaviour is fundamental to understanding associates of PA and health gain, and informing effective programme development.

The Pacific Islands Families (PIF) study offers a unique opportunity to meet this research need. The PIF study follows a cohort of Pacific infants born at Middlemore Hospital, South Auckland, between 15 March and 17 December 2000.

General aims of the PIF study are to:

- Identify and characterise those individuals and families experiencing both positive and negative health outcomes,
- Understand the mechanisms and processes shaping the pathways to those outcomes, and
- Make empirically based strategic and tactical recommendations to improve the wellbeing of Pacific children and families and thereby benefit New Zealand society as a whole.

In-depth information on parent and child health and social, demographic, cultural, and lifestyle factors has been collected from mothers, fathers, and children when the children were 6 weeks, 12 and 24 months, and 4 and 6 years.[22,23]

At the 6-year PIF measurement phase (2006), an additional study (Pacific Islands Families: Child and Parental Physical Activity and Body Size [PIF:PAC]) was conducted, using accelerometry to gather a precise and objective measurement of children's PA and to identify supports for and barriers to children's activity. The

current paper provides a detailed description of the PIF:PAC study design, methodology, and study population.

Methods

Design—The PIF:PAC was a separate nested sub-study, designed to investigate PA levels, sedentary behaviours, and associates of activity behaviours in children and mothers participating in the PIF study's 6-year measurement wave. Existing PIF protocols for home visits and data collection, entry, accuracy, storage, and security were adhered to.[23] Additional protocols and measures specific to the PIF:PAC are described below.

Aims—Specific study aims were to:

- Determine the demographic, health, social, and environmental factors associated with various dimensions of PA, objectively determined by accelerometry (e.g. an examination of differences in accumulated PA associated with body size, ethnic group, socioeconomic status, and/or maternal education level);
- Investigate maternal PA levels and perceived barriers to and facilitators of PA participation, and the relationship these variables have with child PA levels;
- Identify the levels and associations of objectively measured physical inactivity in the sample.(e.g., the relationship between physical inactivity and increased television viewing, family size, maternal education level, and/or ethnic group); and
- Assess the relationship between maternal overweight/obesity, child overweight/obesity, and physical activity levels.

Participant recruitment and enrolment—A comprehensive description of the PIF recruitment process has been published elsewhere.[23] The full PIF cohort comprises 1398 children and their families. High retention has been achieved to date, with 910 children and 1066 mothers participating in the 4-years measurement phase. The full cohort were revisited in 2006 when the children had their sixth birthdays, with the exception of those who had withdrawn from the study over the past 6 years, and those not currently living in New Zealand.

The nature of this longitudinal study allows for those who have not participated in some earlier assessments, to still be eligible for subsequent assessments. The PIF:PAC study ran concurrently with measurement of the substantive PIF variables at 6 years. Due to funding constraints, the first 393 (386 families) eligible PIF participants only were also invited to participate in the PIF:PAC component of the study at the first home visit (see Figure 1).

Participation in the PIF:PAC study was not required for ongoing involvement with the longitudinal PIF study. Mothers willing to participate provided informed consent, and assent was given by participating children. Mothers consenting to participate in the PIF:PAC study were visited at their home on a separate occasion (home visit 2).

At this second home visit, maternal body size was measured and accelerometers provided to participating mothers and children, and written and verbal instructions on their use given. Families were visited approximately 8 days later to collect the accelerometers and pedometers and gather compliance information and participant feedback.

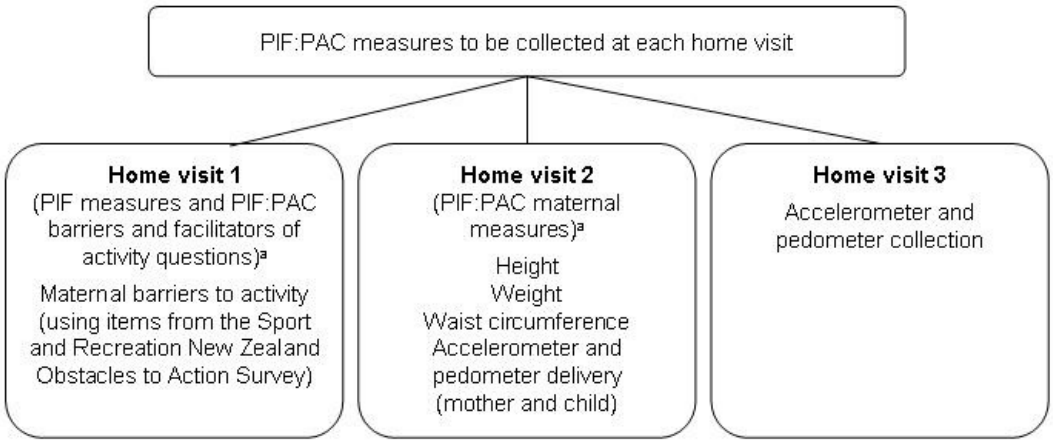
Measures—Figure 1 outlines the measurements specific to the PIF:PAC study that were taken at the 6-year data collection point; detailed descriptions are also provided below.

Child and maternal physical activity—Children and their mothers were visited at their homes by a trained PIF researcher and asked to wear an Actical accelerometer (Mini Mitter, Bend, OR) on a purpose-made elastic waistband for 8 consecutive days (including water activities).

Participants were asked to wear the elastic waistband with the accelerometer sitting above the right hip;[24] appropriate placement was demonstrated to the participants and written instructions for accelerometer use were also provided. Accelerometers were set to collect data in 60-second epochs. The Actical accelerometer is lightweight, water resistant, and contains a piezoelectric sensor that detects movement and acceleration over all planes of movement. This monitor has been validated using indirect calorimetry in both children and adults,[24] and is the only accelerometer that measures omni-directional movement, making it most suitable for use with children.[25]

A measurement period of at least 7 days is recommended to gather a reliable estimate of usual activity, and also enables the comparison of activity during week days and weekend days.[26] Accelerometers were collected by the same researcher approximately 8 days after the initial home visit; information on accelerometer problems and participant compliance was recorded at this time.

Figure 1. Measurement battery for the PIF:PAC study



aChild measures of height, weight, waist circumference, and body fatness were taken during the school data collection visits for the PIF study at six years

Maternal barriers and facilitators of physical activity—Questions to the mothers about barriers and facilitators of PA participation were included within the standard parent interview protocol within the substantive PIF Study. Items from the Obstacles to Action survey[27] were used, to allow comparisons with nationally representative data. This survey was implemented in a nationwide study to identify at-risk groups for insufficient activity, and specific motivators and barriers for physical activity and inactivity for differing groups using a comprehensive range of questions related to attitudes and opinions, individual health, health behaviours, and demographics. Thirty-six items from the physical activity section of this survey (copied verbatim from sections 6 and 8) were utilised in the PIF:PAC study. The interviewer read the survey questions to the parents and recorded their responses.

Maternal body size—Mothers' height was measured to the nearest 0.1 cm using a stadiometer, and weight was assessed using Seca scales to the nearest 0.1kg with the parent in light clothing. Body mass index was calculated as weight (kg) / height (m)^2. Ethnic-specific cut-offs for overweight (26 kg/m^2) and obesity (32 kg/m^2) were used to determine weight status.[28] Waist circumference was measured at the mid axillary line (halfway between the top of the hipbone and the lower rib) to the nearest 0.1 cm and thresholds for high trunk fat mass applied.[29]

Two serial measurements were made for each body size measurement, and the average calculated. If the difference between two readings exceeded 0.5 cm, 0.5 kg, or 1 cm for height, weight, or waist circumference, respectively, a third recording was taken, and the average of the two closest readings taken. These measurements were taken to complement the anthropometric measures (height, weight, waist circumference, body fatness) that were taken of the children during the child assessment at their school as part of the PIF study.

For the children, gender-specific thresholds for high trunk fat mass developed with New Zealand children aged 5.9 years using waist circumference values were applied.[30] International gender-specific thresholds for 6-year-old children were used to define overweight and obesity.[31]

Standard PIF study measures: The following information has been obtained at the first 4 measurement points (6 weeks, 12 and 24 months, 4 years) through interviews and direct child assessments:

- Sociodemographic and cultural factors (e.g. parental demographics, household composition, transport, discriminatory behaviour);

- Child development (childhood activities and experiences, discipline and nurturing, and cognitive, motor, psychosocial and language development);
- Parent and child health issues (child health, parent health, immunisation, nutrition, child anthropometric measures); and
- Family and household dynamics (sharing and support, finance, education, employment).

These structured interviews were repeated with mothers and fathers of the children, and the children themselves at the 6-year measurement phase. Additional data were collected at this time regarding child body size, nutritional practices, and physical activity (basic step-based information and questionnaire), as below:

- Child's body size (height and weight, subscapular and triceps skinfolds, waist and mid upper arm circumference, body fatness by bioimpedance analysis);
- Nutritional practices (eating patterns, food frequency, dietary recall, food beliefs/values); and
- Child and maternal physical activity (self report and proxy report, pedometer steps).

Data accuracy and security—Standard PIF study protocols include a variety of systems to ensure data accuracy and consistency, including: manual coding of each interview (to identify potentially spurious data at the time of data entry), accompanying interviewers to gauge rapport and conduct, participant coding to ensure no individual can be identified from the data, and post interview random phone checks with participants (to confirm specific interview details). All data collected are treated as sensitive information.

Participants own their data and have the right to withdraw this information from the study at any time. Additional checks were completed to determine accelerometer data quality and accuracy for the PIF:PAC study. This involved manual scanning of activity graphs for each participant and identifying corrupt (e.g. constant accelerometer count values for extended periods, scrambled data, and so on) or empty (i.e. no data due to unit not being worn) files and potentially erroneous data (e.g. 0 activity counts for >30 minutes, activity counts exceeding 12,000/60-second epoch, activity counts for >16 hour time periods).

In cases where files were corrupt or empty, these data were excluded from further analyses. Where data were questionable, information was confirmed using the participant compliance information.

Statistical analyses—For the purposes of the current paper, descriptive statistics (frequencies and percentages) of basic sociodemographic variables measured were calculated for participants of the PIF:PAC study and compared with those for the full PIF cohort using the PIF study baseline data (6 weeks).

Ethics—Ethical approval for the PIF and related studies has been obtained from the Auckland Branch of the National Ethics Committee, the Royal New Zealand Plunket Society and the South Auckland Health Clinical Board. Conduct of the study complied with the ethical standards for human experimentation as established by the Helsinki Declaration.

Results

From the original PIF cohort at 6 weeks (N=1376), 1001 mothers participated in the 6-year PIF measurement phase (32% attrition from those eligible at baseline; see Figure 2). Due to funding constraints, the first 386 families were also invited to participate in the PIF:PAC study. Of those invited, 254 (66%) mothers consented for themselves and their child(ren) to participate in the PIF:PAC study, and child assent was gathered for all of these children.

Figure 2. Recruitment characteristics of the PIF:PAC study and PIF study at each measurement phase

Table 1 contains descriptive statistics for basic baseline (6-weeks postpartum) demographic factors of the full PIF cohort and those participating in the PIF:PAC study. The characteristics of participants in the PIF:PAC study were broadly similar to the characteristics measured in the overall cohort. Of those consenting to participate in the PIF:PAC study (254 mothers, 261 children), usable accelerometer data were gathered for 173 (68%) mothers and 200 (77%) children. Seven of these children were twins; in these cases, only the first born twin was included.

Table 1. Frequencies (%) of demographic factors for maternal participants enrolled in the PIF (N=1376) and PIF:PAC (N=254) studies using baseline PIF data (6 weeks)

Variable	PIF study		PIF:PAC study	
	n	(%)	n	(%)
Age (years)[a]				
<20	111	(8)	21	(8)
20–24	354	(26)	62	(25)
25–29	366	(27)	64	(25)
30–34	324	(24)	52	(21)
35–39	176	(13)	41	(16)
≥40	44	(3)	13	(5)
Marital status				
Married/de facto	1107	(80)	203	(80)
Single	269	(20)	51	(20)
Highest educational qualification				
No formal qualification	535	(39)	94	(37)
Secondary	464	(34)	91	(36)
Post-secondary	377	(27)	69	(27)
Ethnicity				
Samoan	650	(47)	125	(49)
Tongan	289	(21)	60	(24)
Cook Island Māori	232	(17)	37	(15)
Niuean	59	(4)	11	(4)
Other Pacific[b]	47	(3)	7	(3)
Non-Pacific[c]	99	(7)	14	(6)
Household income (NZD)				
≤$20,000	457	(33)	94	(37)
$20,001–$40,000	710	(52)	127	(50)
>$40,000	161	(12)	27	(11)
Unknown	48	(3)	6	(2)

Note: 247 mothers in the PIF:PAC study had singletons and 7 had twins – where twins were measured, only the first born twin was included; [a]1 observation invalid; [b]includes mothers identifying equally with two or more Pacific groups; [c]includes non-Pacific mothers who were eligible through the Pacific ethnicity of the father.

Considerable data were lost due to participant non-compliance, researchers not being able to contact the mothers for the second home visit, and accelerometer hardware failure. Descriptive statistics of the accelerometer data collected and missing data are provided in Table 2.

Table 2. Descriptive information for accelerometer data collected in children and their mothers participating in the PIF:PAC study at 6 years (N=254 mothers, 254 children)

Usable accelerometer data collected	n	(%)
Clusters		
Mother and child	156	(61)
Child only	37	(15)
Mother only	17	(7)
Individuals		
Total children	193	(76)
Total mothers	173	(68)
Reasons for accelerometer data loss (mother and child, n=142)		
Unable to schedule appointment	26	(5)
Accelerometer unit lost	4	(1)
Accelerometer hardware failure (data corrupt, battery failure, no data saved)	39	(8)
Participant non-compliance (did not wear accelerometer at all)	60	(12)
Unexplained/other	13	(3)
Descriptive information of raw accelerometer data	mean	(min, max)
Number of days of data		
Child	5.2	(1, 10)
Mother	4.4	(1, 10)
Time worn per day (minutes)		
Child	765	(111, 1184)
Mother	844	(150, 1293)

Height and weight measurements were taken for 238 (94%) participating mothers and 248 (98%) children. Using gender-specific and ethnic-specific body mass index values to classify weight status, 97% of mothers, 58% of girls, and 61% of boys were considered overweight or obese (see Table 3). Waist circumference was measured in 230 mothers and 227 children; of these, a high trunk fat mass was found in 97% of mothers, 53% of girls, and 60% of boys. Barriers to and facilitators of physical activity were also assessed in 254 (100%) mothers participating in the PIF:PAC study (data not reported here).

Table 3. Body size measurements of children and their mothers participating in the PIF:PAC study at 6 years (N=254)

Variables	PIF:PAC study	
	n	(%)
Girls		
BMI status, kg/m^2 (n=120)		
Normal weight/underweight (BMI<17.34)	56	(42)
Overweight (17.34≤BMI≤19.64)	42	(32)
Obese (19.65≤BMI)	35	(26)
Waist circumference status, cm (n=118)		
Low/normal trunk fat mass (<56.4)	56	(47)
High trunk fat mass (≥56.4)	62	(53)
Boys		
BMI status, kg/m^2 (n=109)		
Normal weight/underweight (BMI<17.55)	44	(38)
Overweight (17.55≤BMI≤19.77)	36	(31)
Obese (19.78≤BMI)	35	(30)
Waist circumference status, cm (n=109)		
Low/normal trunk fat mass (<57.0)	44	(40)
High trunk fat mass (≥57.0)	65	(60)
Mothers		
BMI status, kg/m^2 (n=238)		
Normal weight/underweight (BMI<26)	8	(3)
Overweight (26≤BMI<32)	29	(12)
Obese (32≤BMI)	201	(84)
Waist circumference status, cm (n=230)		
Low/normal trunk fat mass (<80)	8	(3)
High trunk fat mass (≥80)	222	(97)

BMI=body mass index status using ethnic-specific thresholds for adults,[28] and international thresholds for children.[31]

Discussion

Internationally, the PIF:PAC is one of the first large-scale epidemiological studies to use accelerometry for objective PA measurement in children and their mother. With the developed world currently suffering from an obesity epidemic, results from this study will provide much sough after evidence in the relationship between familial PA. Furthermore, the combination of PA and longitudinal data from the PIF on both mothers and children will allow important and timely investigations into PA, obesity, and factors contributing to the health and wellbeing of Pacific peoples; a population carrying an abnormally high overweight/obesity load.

Concordant with nationally representative data, a high prevalence of overweight and obesity was observed in Pacific children and their mothers participating in the PIF:PAC study. Body size measures revealed relatively similar results, with 61 or 60% of boys, 58 or 53% of girls, and 96 or 97% of mothers categorised as having high body mass index or waist circumference, respectively.

Overweight and obesity prevalence in our sample was approximately 10% higher than that found for boys and adult females in the NZHS,[5] and identical to that found for girls. The exceedingly high body size measured in the mothers is of concern,

particularly considering that if ethnic-specific thresholds had been applied in the NZHS, it is likely an even greater difference between obesity prevalence in our mothers and the nationally representative sample would have been found.

By using accelerometers in the PIF:PAC study, we have been able to gather a substantial amount of complex and precise information about the PA patterns, intensities, inactivity levels, and duration and timing of in/activity in Pacific children and their mothers that will be explored and described for the first time. Feasibility of using accelerometers with a sub-sample of the PIF cohort was demonstrated; participants were largely compliant, providing detailed PA information over an average of 3–4 days for an average of 13–14 hours.

Application of apposite longitudinal modelling techniques of the activity data will allow us to investigate PA patterning of individuals based on a large amount of data (e.g. 1 day of wear with 10 hours data using 60 second epochs is equal to 600 data points). The method of accelerometer data treatment as well as the longitudinal nature of the PIF study data will also enable the use of powerful repeated measure multivariable regression methods to explore relationships between physical activity, body size, and the associates and determinants of each in great detail.

Demographic information measured in our sample was largely similar to that found in the representative sample participating in the PIF study cohort at 6 weeks; as such findings resulting from this study will be broadly generalisable to the wider Pacific population.

While undoubtedly a strength of the study, the use of accelerometers for research purposes can also prove problematic. Activities such as swimming and cycling are not well captured by hip-mounted accelerometers.[32] Though most participants were compliant, 12% did not wear the accelerometers at all during the measurement phase, and others only wore the units sporadically (resulting in a range of number of days worn and hours worn per day).

Given that 66% of the eligible families participated, it is also possible that the additional burden associated with wearing an accelerometer may have discouraged involvement in the study. The substantial data collected necessitates manual cleaning and processing that is time consuming, and there is no agreed best-practice approach for data reduction and interpretation. Although researchers within our team have devised a robust accelerometer data treatment protocol using generalised estimating equation methods (not presented here), this method currently requires statistical support and considerable resources to complete.

Culturally appropriate, effective, and integrated programmes are urgently required at national and community levels to combat the rising problem of obesity, and to promote healthy lifestyles and well-being for Pacific children and their families. The PIF:PAC study affords the opportunity to better understand the effects of an active (or inactive) childhood.

Findings from the PIF:PAC study, in combination with the substantive PIF study findings, will provide ethnic-specific information on relationships between PA participation and health outcomes in Pacific children. This valuable and timely information can assist stakeholders in their promotion of Pacific health and wellbeing in New Zealand.

The information may be used to inform school and community programmes, create the opportunity to conduct and evaluate randomised prevention trials, and improve the delivery of service and professional practice as it pertains to Pacific family life both locally, and throughout New Zealand.

Competing interests: None known.

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