The Impact of Immigration on Child Health: Experimental Evidence From a Migration Lottery Program[1]

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Abstract

Does migration have a positive or negative impact on the health of the children of migrants? Determining the impact of migration on child health requires a comparison of the current health of the immigrant children to what their health would have been had they stayed in their home country. The latter is unobserved, and is usually proxied by either the health of natives or the health of stayers of a similar age and gender to the migrant child. These approaches are not very convincing because immigrant families are likely to differ from non-migrant families along a host of unobserved dimensions, some of which are likely to be correlated with both child health and migration. This paper uses a unique survey designed by the authors to compare the children of migrants who enter New Zealand through a random ballot with the children of unsuccessful participants in the same ballots who remain in Tonga. Migration is found to have complex effects on children, increasing the stature of infants and toddlers, but also increasing BMI and obesity among pre-teens. Further results provide suggestive evidence that dietary change rather than direct income effects explain these changes in child health.

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1. Introduction

Does migration have a positive or negative impact on the health of the children of migrants? The existing literature cannot answer this question. Much of this literature settles for comparing the health of immigrants and their children to that of native-born groups in the destination country (e.g. Bell et al, 1996; Institute of Medicine, 1998; Frisbie et al, 2001; Gordan et al, 2003, Kirchengast and Schober, 2006). Such comparisons ignore any pre-existing differences between these groups and thus cannot identify the causal effect of migration. A much smaller literature looks at children who remain in their home countries whilst a parent migrates (e.g. Kanaiaupuni and Donato, 1999; Hildebrandt and McKenzie, 2005). These studies can at best determine the impact of having a migrant parent on the health of children, but do not provide information on the health impacts of the child themselves migrating.

Identifying the causal impact of migration on child health instead requires comparing the current health of migrant children to what their health would have been had they stayed in their home country. The only study we are aware that attempts to do this is Smith et al. (2003), which compares children in Maya immigrant families in the US to Maya children in Guatemala. However, there are two serious concerns with this study. First, the examined comparison samples are unrepresentative and are surveyed in different years using different survey instruments. A number of papers in the programme evaluation literature show that both having common survey instruments and comparing representative sample of individuals over the same time period are prerequisites for obtaining unbiased estimates of causal impacts (Heckman et. al, 1998; Angrist, 2004).[2] Second, and even more importantly, the paper assumes that the health of non-migrants children of the same age and gender is an appropriate counterfactual for what the health of migrant children would have been in the absence of migration. This approach is not very convincing because migrant families are likely to differ from non-migrant families along a host of unobserved dimensions, some of which are likely to be correlated with both child health and migration. For example, migrant families are likely to have

[2] In general, there are very few surveys which collect representative data in both the migrant origin and destination countries over the same time periods.

different amounts of wealth or different desires for investing in their children's human capital than non-migrant families, or have experienced shocks, such as a crop failure, that have affected their desire to migrate. Each of these, in turn, is likely to be related to the health of their children.

This paper overcomes both of these problems by examining children's health in the context of a unique survey of participants in a migrant lottery program. The Pacific Access Category (PAC) under New Zealand's immigration policy allows an annual quota of Tongans to migrate to New Zealand in addition to those approved through other migration categories, such as skilled migrants and family streams. The other options available for Tongans to migrate are fairly limited, unless they have close family members abroad. Many more applications are received than the quota allows, so a ballot is used by the New Zealand Department of Labour to randomly select from amongst the registrations. The same survey instrument, designed by the authors, was applied in both Tonga and New Zealand in the same time period and allows experimental estimates of the impact of migration on child health to be obtained by comparing the health of immigrant children whose parents were successful applicants in the ballot to the health of those children whose parents applied to migrate under the quota, but whose names were not drawn in the ballot.

Estimating the causal impact on migration on child health is particularly important, because whereas there is general agreement that migration increases the incomes of households (although the magnitude of this impact is still being debated), there are also concerns that this increase in income, as well as, the cultural changes associated with moving to a new country have negative impacts on both adult and child health.[3] With no estimates of the causal impact on migration on child health available from the literature, it is impossible to know whether this concern is valid or just reflects misinterpreted data and misplaced stereotypes.

[3] For example, see http://vivirlatino.com/2006/03/02/immigration-to-the-us-harmful-to-your-health.php (accessed March 4, 2007)

Migration is found to have complex effects on children, increasing the stature of infants and toddlers, but also increasing BMI and obesity among pre-teens. Further results suggest that dietary change is an important channel through which migration impacts child health and that changes in income, both the direct effect of these changes and their indirect impact via changes in diet, are of limited importance. Differences in relative prices may explain some of this dietary change, but it seems likely that other important mechanisms are also driving this.

The next section briefly discusses a simple theoretical model of why migration might impact child health, summarizes the findings of existing literature on migration and child health, and provides some background information about child health in Tonga. Section 3 describes the survey and the measures of child health used in this study. Section 4 calculates the treatment effect of migration on child health. Section 5 then explores the mechanisms underlying the measured impacts on child health, while Section 6 concludes.

2. Background

Theoretical Model

The literature has identified many potential channels through which immigration may affect the health of children. Hildebrandt and McKenzie (2005) use the Grossman (1972) health production function to provide a theoretical framework which summarizes these various effects. The health of child i at a particular point in time can be written as:

$$H_i = h(M_i, T_i, K_i, B_i, \varepsilon_i) \tag{1}$$

where M_i represents medical and nutritional inputs, T_i encompasses the time inputs of the parent and the time use of the child, K_i is parental health knowledge, B_i represents biological endowments such as genetic factors, and ε_i represents random health shocks. Migration may affect child health through changes in M_i – such as changing diets and changes in access to health care; through changes in T_i – such as less time breastfeeding (Carballo, Divino and Zeric, 1998) and changes in the level of physical activity of children (Unger et al, 2004); and changes in K_i, if parents gain more health knowledge when abroad (Hildebrandt and McKenzie, 2005). However, the main challenge to identifying the impact of migration is that the migration decision of a household might be correlated with either a child's genetic health status, B_i, or with random health shocks, $\varepsilon_{i.}$

Related Literature

While there is a large literature on the health of immigrant children, this identification challenge makes it difficult to ascribe most of the findings to the effects of immigration. As noted above, the majority of the immigrant health literature compares immigrants to native-born in the destination country. In the United States, much attention has been given to the "healthy immigrant paradox", which has found Hispanic immigrants to be of better health than US natives of similar socioeconomic status (Institute of Medicine, 1998). However, in many other contexts immigrant children have been found to be in poorer health than natives. For example, Kirchengast and Schober (2006) report higher rates of obesity among Turkish and Yugoslav immigrant children in Austria than Austrian children and Meulmeister et al. (1990) find higher rates of micronutrient deficiencies and malnutrition amongst Turkish and Moroccan immigrant children than Dutch children in the Netherlands.

However, as discussed above, immigrants differ from natives in many observable and unobservable dimensions, making it difficult to ascribe any of these differences to the impact of migration per se. A number of other studies explore the impact of acculturation by comparing the health of immigrants who have been abroad for differing amounts of time (see Institute of Medicine, 1998, for a review). But, there are several problems which prevent this strategy from giving us the full impact of immigration on health. First, a number of health effects may occur very soon after migrating (or even during the migration journey in some cases) and thus comparing the health of a child who has been abroad one year to one who has been abroad five years will clearly miss the impact of health which occurs during the first year. Second, since both the effect of migration on health is likely to vary with age at arrival and the unobservable characteristics of migrants are likely to vary over time, it is not possible to identify the impact of years in the destination country on health (eg. it is not possible to separately identify age, cohort and year effects).[4] Third, individuals in either the origin or the destination country may have experienced health shocks (say a drought) during the intervening period which should be accounted for when measuring the impact of immigration.

The studies most closely related to ours in terms of geographic focus have compared anthropometric outcomes for Pacific Island children in New Zealand to those for other children in New Zealand. Pacific Island children are taller and heavier for their age than both international reference standards and Caucasian children in New Zealand. For example, the prevalence of obesity in 3-7 year-old Pacific Island children ranges from 42-49%, depending on the criteria used, versus only 7-13% for comparable Caucasian children (Gordon et al, 2003). The mean height and weight of Pacific Island children tracks the 95th percentile of international reference charts until about age 10-11, with height then falling back toward the reference median while weight remains high (Salesa et al, 1997). Both genetic and dietary differences may account for some of these differences across ethnic groups, with Pacific Island children having significantly higher fat intakes than non-Pacific Island children (Bell et al., 1996). However, none of these studies distinguish between immigrant Pacific Island children and those born in New Zealand (who are typically first generation given the timing of migration from the Pacific to New Zealand) and thus have little to say about the impact of migration to New Zealand.

Overall, the scarcity of surveys which contain information on both migrants in the source country and non-migrants in the destination country and the challenge of separating the impact of migration from migrant selectivity limits the ability of the existing literature to identify the health impacts of migration for children. In the next section, we discuss how the unique data used in this paper helps resolve both these problems.

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[4] In addition, selective return migration can cause the characteristics of migrants who have been in the country longer to differ from those who have been in the country for shorter periods.

Tongan Context

Tonga has the lowest infant mortality rate among the Pacific Islands, at 9.1 deaths per 1000 live births, compared to 5.6 per 1000 in New Zealand. Data on malnutrition and stunting are scarce. The World Health Organization (WHO, 2005) reports that there is no chronic undernutrition and no important micronutrient deficiencies in Tonga. However, earlier work (Lambert, 1982, Bloom 1986) suggests that malnutrition may occur during infancy and early childhood, due to delays in the introduction of supplementary food or lack of nutritionally valuable weaning foods and diets too low in protein among children under two years of age. Among adolescents and adults, non-communicable diseases are the most important health problem. The adult obesity rate was 60 percent in 2004 (WHO, 2005), while a recent study of 5-19 year olds also found high rates of childhood obesity, especially amongst girls (Fukuyama et al., 2005).

3. Pacific Island-New Zealand Migration Survey

The data used in this paper are from the first wave of the Pacific Island-New Zealand Migration Survey (PINZMS), a comprehensive household survey designed to measure multiple aspects of the migration process.[5] This survey includes questions on household demographics, education, labor supply, income, asset ownership and food consumption, based where possible on the most widely used surveys in New Zealand and the Pacific Islands to enhance comparability. The survey pays special attention to health issues, relying on both self-reported information (health status, use of health facilities, health behaviors) and anthropometric measurements (blood pressure, height, weight and girth). In particular, parent-rated health status and its change since the previous year and measured height and weight are collected for all children in each sample household.

The unique feature of the PINZMS survey is that it has a mechanism that allows selection biases to be overcome. New Zealand has a special immigration category, established in 2001, called the Pacific Access Category (PAC), which allows an annual quota of 250 Tongans to migrate to New Zealand

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[5] Further details about this survey and related papers produced from these data can be found at www.pacificmigration.ac.nz.

without going through the usual migration categories used for groups, such as skilled migrants and business investors.[6] Specifically, any Tongan citizens aged between 18 and 45, who meet certain English, health and character requirements,[7] can register to migrate to New Zealand.[8] Many more applications are received than the quota allows, so a ballot is used by the New Zealand Department of Labour (DoL) to randomly select from amongst the registrations. Once their ballot is selected, applicants must then provide a valid job offer in New Zealand within six months in order to have their application to migrate approved and be allowed to migrate.

The first wave of the PINZMS data collection was overseen by the authors in 2005/2006 and covered random samples of four groups: (i) Tongan migrants to New Zealand, who were successful participants in the 2002/03 and 2003/04 PAC ballots, (ii) successful participants from the same ballots who were still in Tonga, either because their application for New Zealand residence was not approved (typically because of lack of a suitable job offer) or was still being processed, (iii) unsuccessful participants from the same ballots who were still in Tonga, and (iv) a group of non-applicants in Tonga.[9] The same questions were applied in both New Zealand and Tonga.

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[6] The Pacific Access Category also provides quotas for 75 citizens from Kiribati, 75 citizens from Tuvalu, and 250 citizens from Fiji to migrate to New Zealand.

[7] Data supplied by the DoL for residence decisions made between November 2002 and October 2004 reveals that around 1% of applications were rejected for failure to meet the English requirement and around 3% were rejected for failing other requirements of the policy.

[8] The person who registers is a Principal Applicant. If they are successful, their immediate family (spouse and children under age 18) can also apply to migrate as Secondary Applicants. The quota of 250 applies to the total of Primary and Secondary Applicants, and corresponds to about 70 migrant households.

[9] The initial sample frame for groups (i) and (ii) was a list of the names and addresses of the 278 (out of almost 3000 applicants) successful participants in the 2002/03 and 2003/04 migration ballots, which was supplied under a contractual arrangement with the New Zealand Department of Labour, with strict procedures used to maintain the confidentiality of participants. Approximately 100 of these successful ballots had been approved for residence in New Zealand by the time of the survey, although some of those families had not yet moved to New Zealand. We managed to locate 65 of the families that had migrated, giving a sampling rate of over 70 percent, and drew a random sample of 55 of the successful ballots that had not yet migrated. This non-migrant group includes those whose applications were rejected and those whose applications were still being processed. We use the actual number of accepted and rejected applications to weight our sample. The initial sample frame for the unsuccessful ballots (group (iii)) was a list of names and addresses provided by the DoL. We derived a sample of 78 unsuccessful ballots from this information, implicitly stratifying by island and by the village of residence when the applicant entered the ballot. The sample of non-applicants was obtained by selecting 60 households, with at least one member aged 18 to 45, in either the same villages that the migrants had been living in prior to migrating or in the same villages that unsuccessful ballots were found in.

The probability of success in these ballots is less than 10%. Thus, we have a group of migrants and a comparison group who are similar to the migrants, but remain in Tonga only because they were not successful in the ballot. This allows experimental estimates of the impact of migration on child health to be obtained by comparing the health of children whose parents were successful applicants in the ballot to the health of those children whose parents applied to migrate under the quota, but whose names were not drawn in the ballot.

Our analysis focuses on nine measures of child health. The first two are *parent-reported measures of each child's health status in the current year* and their *health status compared to one year ago* on five-point scales. Self-reported health status has the virtue of being quick to collect, making it a common question on multipurpose surveys, such as the New Immigrant Survey in the U.S. (Jasso et al. 2004), despite evidence of systematic differences in responses by socioeconomic status (Sindelar and Thomas, 1991). These questions provide an indication of the level of and changes in overall health status, however, there are reasons to worry that parental responses to these questions may change with migration, regardless of whether health actually changes. For example, when reporting whether or not their child is in good health, migrant parents may compare their children to a reference group of New Zealand children, rather than to the health standards of children back in Tonga.

Physical indicators of nutrition are not subject to respondent-specific reporting error and are of direct interest themselves as they have been shown to be indicative of health status and correlated with economic prosperity. The remaining seven measures of child health are derived from height and weight data. These measurements were directly collected by trained interviewers during the in-person surveys, and are adjusted for whether the child is measured lying down or standing, whether they are wearing shoes, and the type of clothing being worn.[10] We examine three continuous measures of child

[10] Height was measured to the nearest 0.1 cm using a portable stadiometer (Schorr Height Measuring Board, Olney, MD) and weight was measured to the nearest 0.1 kg on a digital scale (Model UC-321; A&D Medical, Milpitas, CA).

anthropometry; *height*, *weight* and *BMI*, each *standardised by age in months and gender*.[11] These measures are each expressed as *z*-scores which show how many standard deviations each child is away from the age- and gender-specific median height, weight, or BMI in a reference population of well-nourished children.[12]

Our final four measures are threshold measures derived from the standardised height and BMI *z*-scores based on US Center for Disease Control (CDC) recommendations; *stunting* is defined as having standardised height below the 5th percentile of the reference population and indicates chronic undernutrition and poor health, *underweight* as having standardised BMI below the 5th percentile, *overweight* as having standardised BMI between the 85th and 95th percentiles and *obese* as having standardised BMI above the 95th percentile of the reference population (Kuczmarski, Ogden and Grummer-Strawn, 2000).[13]

Child height (or stature) is generally known to be a sensitive indicator to the quality of economic and social environments (Steckel, 1995), while child weight and, more typically, BMI have been demonstrated to be good measures for identifying short-run effects on health (Strauss and Thomas, 1998). A number of studies have shown that the relationship between socioeconomic status and child health varies with the age of the child (Sahn and Alderman, 1997; Case, Lubotsky and Paxson, 2002).

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[11] BMI refers to the body mass index which is measured as weight in kilograms divided by height in meters squared. This has been shown by nutritionists to best measure energy intakes net of energy output.

[12] We use the 1990 reference standards for the United Kingdom, as derived in Cole et al. (1998), for each of these measures as they are available for children of all ages. We find similar results using non-standardised measures of height, weight, and BMI, but focus on the standardised results for comparability with the literature.

[13] There is considerable debate about the validity of using a universal BMI cutoff points for comparing obesity prevalence across ethnic groups. Rush (2003) show that for the same BMI, the percent body-fat for Pacific Island children is lower than that for NZ children of European origin. Rush (2004) reports similar finding for young adults, for example, they find that the average body-fat for a young adult Pacific Islander with a BMI of 33 is the same as that for a young adult of European origin with a BMI of 30. However, since we are comparing BMI for Tongan children in New Zealand to Tongan children in Tonga, as opposed to comparing immigrant children to natives, as is common in much of the literature, this debate about using ethnic-specific BMI cutoffs should not be a concern.

Thus, we stratify our analysis of the impact of migration on child health into four age-groups across which impacts are likely to differ; 0-2 year-olds, 3-5 year-olds, 6-12 year-olds, and 13-18 year-olds.[14]

4. The Effect of Migration on Child Health

This section focuses on estimating the impact of migration to New Zealand on the health of Tongan children. We rely on the fact that the PAC ballot, by randomly denying eager migrants the right to move to New Zealand, creates a control group of children that should have the same outcomes as what the migrant children would have had if they had not moved. Evidence that the control group of non-migrants are statistically identical to the migrants in terms of *ex ante* characteristics is reported in Table 1. We can not reject equality of means for any variable among all children (0-18 year-olds), other than father's age, which is consistent with the random selection of ballots among applicants in the PAC ballot

Table 2 presents the proportion of parents reporting their children are in very good health, as opposed to good or average health,[15] the proportion of parents reporting their children are in much better health now compared to a year ago, as opposed to somewhat better now, about the same now, or somewhat worse health now,[16] the mean z-score for each anthropometric measure, and the proportion of children that are stunted, underweight, overweight, and obese, among children in each of the four age-groups whose parents were either successful or unsuccessful in the PAC ballot (and standard errors for each which account for clustering at the household level and survey stratification and weighting).

[14] Environmental factors are especially important determinants of child height in early childhood. Therefore, the World Health Organization recommends focusing analysis of height measures to children 0–5 years old (WHO, 1986). The stature of infants and children is particularly vulnerable to nutritional stresses and, in our example, these children changed environments during this vulnerable stage in life (all 0-2 year-olds in our sample were born in Tonga, because they had to be included in the ballot application to be included in our sample, and thus were mainly brought to New Zealand as infants). Thus, we further split the 0-5 age-group. Teenagers are often dropped when examining child health, because the onset of puberty is thought to be weakly related to underlying health status, thus making it difficult to measure the true relationship between other covariates and health status. Instead of dropping teenagers, we examine their outcomes separately.

[15] Only 11 of the 123 non-very good responses are average.

[16] Only 39 of the 211 non-much better health response are about the same now and only 2 are somewhat worse health now. This variable is coded as missing for children less than one although parents typically gave a response for these children as well.

Infants and toddlers in households whose parents were unsuccessful in the PAC ballot are generally short in stature compared to the reference population and are very likely to be stunted (43% of 0-2 year-olds), however they have relatively high BMI and 42% are classified as obese for their age. Most of their parents consider these children to be in very good health. Mean standardised height is closer to the reference population for older children whose parents were unsuccessful in the PAC ballot, but, in each age-group, a larger proportion than expected are stunted (11%, 13%, and 16%, respectively for 3-5, 6-12, and 13-18 year-olds versus 5% in the reference population by definition). These children are still, in general, heavier than the reference population and are more likely to be overweight and obese, in particular 6-12 and 13-18 year-olds. The proportion whose parents view them in very good health declines for each older age-group.

In a perfect randomised experiment, the impact of the treatment (here, migration) on each outcome can be obtained via a simple comparison of means or proportions in the control group (unsuccessful ballots) to the treatment group (successful ballots). However, as discussed in Heckman et. al. (2000), this simple experimental estimator of the treatment effect on the treated is biased if control group members substitute for the treatment with a similar program or if treatment group members dropout of the experiment. In our application, *substitution* bias will occur if PAC applicants who are not drawn in the ballot migrate through alternative means and *dropout* bias will occur if PAC applicants whose name are drawn in the ballot fail to migrate to New Zealand.

We do not believe that substitution bias is of serious concern in our study, as individuals with the ability to migrate via other arrangements will likely have done so previously given the low odds of winning the PAC ballot.[17] Furthermore, the other options available for Tongans to migrate are fairly limited, unless they have close family members abroad. Ninety-four percent of all Tongan migrants are located in New Zealand, the United States and Australia, and the PAC accounts for 42% of all

[17] We did not come across any incidences where remaining family members told us that the unsuccessful applicant had migrated overseas during our fieldwork.

migration to these three countries, and over 90% of non-family category migration.[18] However, as shown in Table 1, dropout bias is a more relevant concern; only 56% of ballot winners (weighted by the number of their children) had migrated to New Zealand at the time of our survey. A number of the other ballot winning households are in the process of moving, while others are unable to move due to the lack of a valid job offer in New Zealand for the household principal applicant.[19]

Experimental data, in the presence of substitution and dropout bias, can identify the mean impact of a program (eg. winning the ballot) on outcomes, also known as the intention-to-treat effect (ITT).[20] This estimator is unbiased by virtue of the randomization of ballot winners and losers and can be computed by comparing the mean outcome for ballot winners to that for ballot losers. The t-tests reported in each panel in Table 2 show whether winning the ballot has a significant ITT effect on each outcome for each age-group and the size of the impact can then be calculated by subtracting the mean outcome for children with unsuccessful ballots from the mean outcome for those children with successful ballots.[21]

These results indicate that winning the ballot causes a significant decline in the parent-reported health status of 0-2 year-olds, an increase in standardised height for 0-2 year-olds, an increase in standardised weight for 3-5 and 6-12 year-olds, an increase in standardised BMI for 3-5 year-olds, and an increase in underweight 0-2 year-olds and obese 3-5 year-olds. These ITT estimates are difficult to interpret directly both because many individuals in the treatment group actually fail to receive the

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[18] See McKenzie, Gibson and Stillman (2006).

[19] Ballot winners have six months to lodge a formal residence application containing evidence of a job offer. It then typically takes three to nine months for applicants to receive a decision on their application, after which those who are approved have up to one year to move. Relatively few applications are rejected due to lack of a valid job offer, but lack of a job offer prevents many ballot winners from lodging residence applications. Approximately 75 percent of the ballot winners still in Tonga at the time of our survey had migrated to New Zealand by 22 September 2006.

[20] The terminology *intent-to-treat* comes from the medical literature, and refers to analysis based on the original random assignment of individuals to treatment or control groups, regardless of whether or not individuals actually received or complied with the treatment. In our context, it gives the impact of assignment to migration status through the ballot, regardless of whether individuals who win the ballot actually migrate or not.

[21] These t-tests account for clustering at the household level and survey stratification and weighting

treatment (eg. migrate) and because of the potential dropout bias arising from non-random migration among those who do win the ballot.

Instrumental variables provide an approach for estimating average treatment effects with experimental data. In our application, the PAC ballot outcome can be used as an excluded instrument because randomization ensures that success in the ballot is uncorrelated with unobserved individual attributes which might also affect child health and success in the ballot is strongly correlated with migration (the first stage F-statistic is 30.82 and the partial R-squared is 0.3658 from a model pooling all children).[22] This estimate is called the local average treatment effect (LATE) and can be interpreted as the effect of treatment on individuals whose treatment status is changed by the instrument. Angrist (2004) demonstrates that in situations where no individuals who are assigned to the control group receive the treatment (eg. there is no substitution) then the LATE is the same as the average treatment effect on the treated (ATT).

Table 3 presents two sets of results using the ATT estimator for each outcome and age-group. Linear instrumental variables is used for each continuous outcome (the three standardised anthropometric measures), while instrumental variable maximum likelihood probit models are estimated for each discrete outcome (the remaining six outcomes).[23] In both cases, whether an individual has migrated to New Zealand is instrumented by whether their household was successful in the PAC ballot and marginal effects and their associated standard errors are presented which account for clustering at the household level. All regressions use the appropriate survey weights to account for the sampling rates for each group.

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[22] Validity of the instrument also requires that the ballot outcome does not directly affect child health conditional on migration status. It seems unlikely to us that winning the ballot and not being able to migrate would impact the health status of children in the household.

[23] Too few 6-12 and 13-18 year-olds are underweight to estimate the regression models for this outcome for these age-groups. The IV probit models occasionally fail to converge when few/all individuals in one of the groups (unsuccessful ballots, successful ballots in Tonga, and successful ballots in New Zealand) have a particular outcome (e.g. the group is a nearly a perfect predictor of the outcome). These situations are noted in the results.

The first row in each panel reports the ATT estimate when no other controls are included in the regression model. For 0-2 year-olds, we find that migration leads to a significant 66% decline in the likelihood of very good parent-reported health status, a 3.08 standard deviation increase in standardised height relative to the reference population, a 44% decline in the likelihood of being stunted and a 90% increase in the likelihood of being underweight.[24] For 3-5 year-olds, we find that migration leads to a significant 2.27 standard deviation increase in standardised weight and a 2.47 standard deviation increase in standardised BMI relative to the reference population (significant at the 10% level), a 12% decline in the likelihood of being underweight, and a 90% increase in the likelihood of being obese. For 6-12 year-olds, we find that migration leads to a significant 32% increase in the likelihood of very good parent-reported health status (significant at the 10% level) and a 1.95 standard deviation increase in standardised weight relative to the reference population. For 13-18 year-olds, we find that migration leads to a significant 39% increase in the likelihood of very good parent-reported health status and a 18% decline in the likelihood of being stunted.

The second row in each panel then re-estimates the previous regression including controls for each child's gender, age in months, age in months squared, birth order position, and their parent's age and height. Including controls for these pre-determined variables should increase the efficiency of our estimates. Most of the estimates remain qualitatively unaffected by the addition of covariates. The exceptions include: we now find a 69% increase in the likelihood of being in much better health than a year ago and a 57% decline in the likelihood of being obese for 0-2 year-olds, the decline in the likelihood of being underweight for 3-5 year-olds is no longer significant, and we now find a 28% decline in the likelihood of being in much better health than a year ago and a 69% increase in the likelihood of being overweight for 13-18 year-olds (significant at the 10% level), while the positive impact on parent-rated health is no longer statistically significant.

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[24] The large size of the marginal effect on being underweight, as well, as some of the other large marginal effects reported below are likely caused by the fact that certain outcomes are extremely uncommon in either the migrant or non-migrant sample and thus the assumption that the unobserved error distribution is normal impacts the absolute size of the effects. However, these can still be interpreted as very large effects approaching plus or minus infinity.

Overall, migration is found to have complex effects on children. Migration increases the stature of infants and toddlers and reduces the likelihood that they are obese, but also increases the likelihood that they are underweight and reduces their parent's opinion of the level of their health status. Among 3-5 year-olds, migration increases weight and BMI and leads to large increases in the likelihood of being above the obesity threshold. Migration also increases the weight of pre-teens, but has an insignificant impact on BMI. Parent-rated health significantly improves for this group. Little impact is found for teenagers, with the only strongly significant results being that migration leads to a decline in parent-reported improvement in health status.[25]

The contrasting results for 0-2 year-olds and 3-5 year-olds are particularly interesting. These results are consistent with migration leading to higher calorie diets for all young children, but translating to an increase in stature for 0-2 year-olds and an increase in weight for 3-5 year-olds. As noted earlier, there is some evidence that late transition to solid food and inadequate nutritional content of weaning foods has resulted in malnutrition during early childhood in the Pacific. International evidence has shown nutritional supplementation to only have an impact on stunting and height under the age of 3 (Schroeder et al, 1995; Branca and Ferrari, 2002). Beyond this age, additional nutrition is unlikely to have much impact on height. However, excess energy intake through an increase in calories can of course still lead to weight increases, as has happened here with the 3-5 year olds. Interestingly, the large increase in the propensity of being underweight for 0-2 year-olds is entirely driven by the large increase in average height, because it is not accompanied by any change in the average weight of these children.

[25] In unreported results, we also examined whether the impact of migration on child health is related to the amount of time that the children have lived in New Zealand. We find that, in general, migration has significant impacts on the same outcomes and that the magnitude of these impacts grow linearly with time spent in New Zealand (e.g. the average monthly impact equals the total impact reported in Table 3 divided by the mean number of months living in New Zealand for children in each age-group).

Table 4 presents results from identical models as in the second specification in Table 3 (e.g. including covariates), but allows the impact of migration to differs for boys and girls. Also, presented for each outcome is the p-value for a Wald-test that the impact on girls and boys differ. Unfortunately, a number of discrete outcome models fail to converge because of either few/most boys to girls having a particular outcome and few of the impacts are measured with enough precision to enable strong comparisons between the impact on boys versus girls.

We find suggestive evidence that the positive impact on stature for infants and toddlers is stronger for girls (the impact for girls in strongly significant, while that for boys is insignificant, but the p-value for the impact being different is only 0.29) and that the impact on weight and obesity is stronger for boys in the 3-5 age-group (for example, standardised BMI increases by 5.33 for boys and insignificantly for girls and these impact differ at the 10% level of significance), but for girls in the 6-12 age-group (for example, obesity increase by 67% for girls, but insignificantly for boys and these impact differ at the 10% level of significance). We also that find that when we stratify our results by gender, migration has positive impact on parent-rated health status and leads to a 62% decline in obesity for 13-18 year-olds girls (results are opposite signed for boys, but standard errors are large enough that we cannot reject the impacts being the same at conventional levels of significance).

5. Interpreting the Results

Migration appears to have complex effects on child health, many which are large in magnitude. In this section we attempt to understand some of the channels through which these effects may operate. Given the problems of interpreting parental assessments of health, e.g. the reference group may change with migration, we focus on explaining the changes in anthropometric outcomes. Returning to equation (1), we see that health outcomes may change as a result of changes in material inputs, time inputs, and health knowledge. Our data only allow us to examine the impact of changes in material inputs, although we will discuss how changes in the other two types of factors could related to our results.

Increases in income changes the ability of a household to purchase food and medical inputs which affect child health production. As shown in McKenzie, Gibson and Stillman (2006), migration from New Zealand to Tonga results in large increases in earned income among principal applicants. Re-estimating the main treatment effect model from that paper to examine the impact on total household income among migrant households with children, we find that migration increases annual total household cash income by around 15,725 New Zealand dollars for these households relative to an average annual total household cash income of 12,100 New Zealand dollars among unsuccessful lottery applicants in Tonga.[26] A number of studies find a strong relationship between household income and child health (Case, Lubotsky and Paxson, 2002), thus we first examine whether these income increases are likely to be related to the estimated impacts of migration on child health.

In Table 5, we present results from estimating the relationship between child health and child and parent characteristics,[27] log total household cash income,[28] log total household imputed value of own-production,[29] and log distance from the nearest doctor[30] among all children in all households in Tonga (e.g. non-applicant households, unsuccessful ballot households, and successful ballot household that have failed to migrate). Again, we estimate OLS models for each of the continuous outcomes and probit models for the discrete outcomes and present marginal effects and their associated standard errors which account for clustering at the household level. Consistent with international evidence, children in wealthier households appear to be in better health - they are taller in stature and have lower standardised weight and BMI (and are less likely to be obese at the 10% significance level), although their parents are significantly less likely to report them in very good health. However, in all cases, the

[26] Total household cash income includes labour earnings, agricultural income, pension and investment income, and the receipt of social benefits. It does not include the imputed value of own-produced foods that are consumed by the household.
[27] We include all of the covariates from the treatment effects regressions as well as controls for the total number of children in the household, whether the child lives with both of their parents, and each parent's years of education.
[28] We also estimate the same models controlling for a quadratic in income. The models using log earnings best fit the data and results are qualitatively the same in each case.
[29] The value of own-production is imputed using self-reported valuations of own produce consumed in week before the survey. We control for this separately because own-production is likely to be directly related to child anthropometrics due to the different foods consumed by households with crops versus those without own production.
[30] This is calculated using GPS data on the location of each household and of each medical centre.

income-child health gradient is quite weak – for example, the relationship between a 100% increase in household earnings and standardised BMI, which has the strongest gradient, is less than the relationship between gender and standardised BMI.[31]

In Table 6, we present results from estimating the relationship between child health and the same child and parent characteristics as in Table 5 among all children in the sampled households in New Zealand.[32] We also control for the change in household labour earnings each household experienced from moving to New Zealand and the number of months they have lived in New Zealand.[33] Again, we estimate OLS models for each of the continuous outcomes and probit models for the discrete outcomes and present marginal effects and their associated standard errors which account for clustering at the household level. Perhaps surprisingly, the magnitude of the change in earnings experienced by each household has little relationship to the health of the children in that household. The only significant findings are that a 100 NZD increase in weekly earnings is associated with a 3.5% reduction in the likelihood of parents reporting their children as having much better health than a year ago and 1.1% reduction in the likelihood of children being overweight.

Taken together, these results suggest that, even with the large income gains experienced by migrant households, changes in income explain little of the estimated impact of migration on child health. For example, the results for Tongan households provide evidence that income is positively related to child stature, but the magnitude of relationship is not strong enough to explain more than a tiny amount of the impact of migration on the stature of infants and toddlers (we estimate that migration increases stature by 3.91 standard deviations for this age-group and a 100% increase in cash income in Tonga is associated with only a 0.18 standard deviation increase in stature). Even more strikingly, while

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[31] Tongan girls are 0.52 standard deviations heavier than boys compared to the reference populations, while a 100% increase in household income is associated with being 0.36 standard deviations lighter.

[32] Almost no children are stunted (7 out of 107) or underweight (1 out of 100) in New Zealand, thus these outcomes are dropped from this table.

[33] All adults surveyed in New Zealand report how much they earned in a usual week in the six months prior to migrating. Thus, we can calculate the change in household earnings by summing up prior earnings and current earnings for each household and subtracting the first from the second. The mean change in weekly earnings in our sample of households in New Zealand weighted by the number of children in the sample is 460 NZD.

wealthier households in Tonga and New Zealand are less likely to have heavier children, we find that migration has a large positive impact on the weight of pre-teens.

Dietary change is another pathway through which migration is likely to impact child health. Not only is the availability of goods hugely different between Tonga and New Zealand, the relative prices of goods available in both countries also differs immensely. Existing literature also suggests that major dietary changes occur for Pacific Islanders following migration to New Zealand (Harding et al., 1986). Thus, we next examine whether changes in diet are likely to be related to the estimated impacts of migration on child health.

Table 7 presents results from estimating the ATT of migration on diet. Specifically, we collect information from all households on whether any of thirty different foods were eaten by any member of the family during the day prior to the interview. For twenty-seven of these foods, we also asked during how many meals were these foods eaten. The list of foods is identical in Tonga and New Zealand making a direct comparison of diet composition possible. To focus our analysis, we examine the cumulative number of meals in which eight foods are consumed, five of which are composites. These foods are: rice, roots, fruits and non-root vegetables, fish, fats, meats, milk and sweets.[34] As in Table 3, we estimate linear instrumental variables for each outcome (except sweets which is discrete and thus we estimate an instrumental variable maximum likelihood probit model) using whether the household was successful in the PAC ballot to instrument for whether the individual has migrated to New Zealand. These models are estimated with one observation per-child to allow all covariates from the second specification of the child health regression models to be included in these regressions as

[34] Roots include taro (swamp taro), taro taruas (chinese taro), kumara (sweet potato), taamu/kape, yams, cassava/manioc, and potato. Fruits and non-root vegetables include other vegetables, coconut (fresh and dry), banana, mango, pawpaw, and other fruits. Fish includes tinned fish and fresh fish. Fats include corned beef, mutton, and coconut (fresh and dry). Meats include corned beef, mutton, fresh beef, chicken, pork, and other meat (eg. sausage). Sweets are one of the foods where the number of meals is not recorded, thus this is a discrete outcome.

well (results are presented both with and without covariates), and thus the results can be interpreted at the impact of migration on the diet of the average child in the sample.[35]

These results indicate that migration leads to a significant increase in the consumption of meats, milk, and sweets. These changes in diet are large; consumption of meats increases by 50-70%, consumption of milk goes up almost fifteen-fold, and the likelihood of consuming sweets increases by 91%. Migration also leads to a large, but marginally significant, decrease in the consumption of fruits and vegetables. While we cannot directly relate changes in diet to changes in child health because we do not know which household members are consuming which food, these results suggest that dietary change is directly related to changes in child health. Increased consumption of meats and milk would lead to increased protein and other micronutrient intake, which have been shown to increase the stature of infants and toddlers (Branca and Ferrari, 2002). On the other hand, increased consumption of these goods along with sweets would lead to increase in overall calorie and fat intakes, which is directly related to weight gain.

A number of factors could contribute to changing diets. As mentioned above, relative food prices are quite different in New Zealand versus Tonga and most migrant households have experienced large increases in income. However, we find low cash income elasticities for most foods in Tonga.[36] Perhaps, more importantly, the marketing of foods and the availability of different foods is likely to be vastly different between these countries. Table 7 also displays the relative Tongan to New Zealand market price for each food item. The estimated changes in diet are somewhat consistent with relative prices being a factor – for example, meats and milk are relatively cheaper in New Zealand than in Tonga compared to other foods (in particular, roots and fish). A further important factor affecting

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[35] Again, standard errors are presented which account for clustering at the household level and all regressions use the appropriate survey weights to account for the sampling rates for each group. We also include day of the week fixed effects in the regressions with covariates to account for temporal patterns in food consumption.
[36] Households with higher cash incomes are not consuming significantly different amounts of fruits, vegetables, milks or meat. In contrast, consumption patterns do vary with the level of own food production, which does not take place among Tongan households in New Zealand.

relative prices is that many Tongan households grow or raise some of their own food, whereas none of the Tongan migrant households in our survey do.

Overall, these results suggest that dietary change is an important channel through which migration impacts child health and that changes in income, both the direct effect of these changes and their impact on diet, are of limited importance. Differences in relative prices may explain some of this dietary change, but it seems likely that other important mechanisms are also driving this. Another potentially important channel is changes in household structure. For example, ATT estimates indicate that migrant households have almost 75% fewer adult women members. We suspect that having fewer female extended family members around to help prepare meals could be a large contributor to a shift towards less healthy diets. It is also important to note that there are a number of other channels through which migration may impact child health that our data do not allow us to examine. For example, changes in antenatal practices, such as breastfeeding, might explain the increased stature of infants in New Zealand, while reductions in physical activity might play an important role in explaining the increased BMI of pre-teens. It is also possible that maternal health knowledge about nutrition during early childhood may improve in New Zealand.

6. Conclusions

This paper overcomes the selection problems affecting previous studies of the impact of migration on child health by examining a migrant lottery program. The Pacific Access Category (PAC) under New Zealand’s immigration policy allows an annual quota of Tongans to migrate to New Zealand in addition to those approved through other migration categories, such as skilled migrants and family streams. Many more applications are received than the quota allows, so a ballot is used by the New Zealand Department of Labour to randomly select from amongst the registrations. A unique survey designed by the authors allows experimental estimates of the impact of migration on child health to be obtained by comparing the health of immigrant children whose parents were successful applicants in the ballot to the health of those children whose parents applied to migrate under the quota, but whose names were not drawn in the ballot.

Migration is found to have complex effects on children, increasing the stature of infants and toddlers, but also increasing BMI and obesity among pre-teens. Further results suggest that dietary change is an important channel through which migration impacts child health and that changes in income, both the direct effect of these changes and their impact on diet, are of limited importance. Differences in relative prices may explain some of this dietary change, but it seems likely that other important mechanisms, such as changes in household structure, are also driving this.

It is also important to note that there are a number of other channels through which migration may impact child health that our data does not allow us to examine. For example, changes in antenatal practices, such as breastfeeding, might explain the increased stature of infants in New Zealand, while reductions in physical activity might play an important role in explaining the increased BMI of pre-teens. Further research is needed to examine these effects, as well as to determine interventions which can help lower the rate of obesity among older children in immigrant households.

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TABLE 1: TEST FOR RANDOMIZATION

Comparison of Ex-ante characteristics of children <= 18 in successful and unsuccessful ballots

	Sample Means APPLICANTS		T-test of equality of means
	Successful Ballots	Unsuccessful Ballots	p-value
Proportion Children 0-2 Years-Old	0.14	0.17	0.45
Proportion Children 3-5 Years-Old	0.17	0.22	0.21
Proportion Children 6-12 Years-Old	0.48	0.40	0.13
Proportion Children 13-18 Years-Old	0.21	0.21	0.98
Age in Months	104.2	99.0	0.52
Proportion Female	0.46	0.46	0.89
Proportion Live with Both Parents	0.97	0.93	0.32
Number of Children in Household	4.1	4.4	0.55
Father's Age	39.7	37.9	0.08
Father's Years of Education	11.6	11.3	0.35
Father's Height	165	165	0.99
Mother's Age	37.9	36.2	0.17
Mother's Years of Education	11.4	11.0	0.41
Mother's Height	163	163	0.83
Proportion in NZ	0.56		
Months in New Zealand	9.9		
Total Sample Size	**208**	**169**	

Test statistics account for clustering at the household level and survey stratification and weighting

TABLE 2: SUMMARY STATISTICS - Sample Means (Standard Errors)

	Very Good Parent-Rated Health	Much Better Health Since Last Year	Standardised Height For Age	Standardised Weight For Age	Standardised BMI For Age	Stunted Height for Age < 5th Pctile	Underweight BMI for Age < 5th Pctile	Overweight BMI for Age 85 - 95th Pctile	Obese BMI for Age >= 95th Pctile
Children 0-2 Years-Old									
Successful Ballots	0.49	0.41	0.46	-1.02	0.37	0.19	0.25	0.07	0.41
	(0.10)	(0.13)	(0.51)	(0.75)	(0.55)	(0.12)	(0.10)	(0.07)	(0.11)
Unsuccessful Ballots	0.78	0.39	-1.16	0.08	1.41	0.43	0.04	0.08	0.42
	(0.08)	(0.13)	(0.39)	(0.32)	(0.41)	(0.09)	(0.04)	(0.06)	(0.11)
T-test of equal means (p-value)	0.03	0.90	0.01	0.19	0.13	0.10	0.06	0.90	0.98
Sub-Sample Size	55	38	41	42	43	41	43	43	43
Children 3-5 Years-Old									
Successful Ballots	0.59	0.49	0.12	1.18	1.21	0.09	0.10	0.18	0.33
	(0.10)	(0.10)	(0.34)	(0.44)	(0.45)	(0.06)	(0.06)	(0.07)	(0.10)
Unsuccessful Ballots	0.76	0.34	0.07	0.13	0.21	0.11	0.11	0.17	0.03
	(0.07)	(0.09)	(0.23)	(0.24)	(0.22)	(0.05)	(0.05)	(0.06)	(0.03)
T-test of equal means (p-value)	0.16	0.28	0.91	0.04	0.05	0.79	0.86	0.95	0.01
Sub-Sample Size	76	76	68	69	66	68	66	66	66
Children 6-12 Years-Old									
Successful Ballots	0.67	0.39	0.04	1.49	1.67	0.15	0.00	0.18	0.44
	(0.05)	(0.07)	(0.23)	(0.23)	(0.23)	(0.04)	(0.00)	(0.04)	(0.07)
Unsuccessful Ballots	0.55	0.42	-0.32	0.83	1.31	0.13	0.02	0.18	0.32
	(0.07)	(0.08)	(0.19)	(0.18)	(0.20)	(0.04)	(0.02)	(0.06)	(0.07)
T-test of equal means (p-value)	0.20	0.78	0.22	0.03	0.25	0.83	0.32	0.92	0.26
Sub-Sample Size	165	165	151	155	153	151	153	153	153
Children 13-18 Years-Old									
Successful Ballots	0.70	0.31	-0.77	1.07	1.62	0.29	0.04	0.33	0.44
	(0.07)	(0.09)	(0.28)	(0.36)	(0.31)	(0.12)	(0.04)	(0.08)	(0.12)
Unsuccessful Ballots	0.53	0.42	-0.46	1.16	1.48	0.16	0.06	0.16	0.58
	(0.08)	(0.09)	(0.23)	(0.21)	(0.34)	(0.07)	(0.06)	(0.06)	(0.10)
T-test of equal means (p-value)	0.10	0.40	0.41	0.83	0.76	0.35	0.76	0.10	0.37
Sub-Sample Size	80	80	67	68	67	67	67	67	67
Total Sample Size	**376**	**359**	**327**	**334**	**329**	**327**	**329**	**329**	**329**

Test statistics and standard errors account for clustering at the household level and survey stratification and weighting

TABLE 3: IV ESTIMATES OF EXPERIMENTAL IMPACT (IV Probit Marginal Effects for Outcomes (1) - (2), (6) - (9), Linear IV for Remainder)

	Very Good Parent-Rated Health	Much Better Health Since Last Year	Standardised Height For Age	Standardised Weight For Age	Standardised BMI For Age	Stunted Height for Age < 5th Pctile	Underweight BMI for Age < 5th Pctile	Overweight BMI for Age 85 - 95th Pctile	Obese BMI for Age >= 95th Pctile
				Children 0-2 Years-Old					
No Control Variables	-0.657***	0.037	3.075**	-2.966	-3.750	-0.435***	0.898***	-0.084	-0.016
	(0.232)	(0.518)	(1.318)	(2.791)	(2.923)	(0.094)	(0.177)	(0.057)	(0.555)
Control Variables	-0.766***	0.691**	3.907**	-2.863	-4.115	-0.426***	0.987***	-0.042	-0.565***
	(0.186)	(0.308)	(1.586)	(2.531)	(3.004)	(0.106)	(0.022)	(0.030)	(0.145)
Sub-Sample Size	55	38	41	42	43	41	43	43	43
				Children 3-5 Years-Old					
No Control Variables	-0.290	0.345	0.098	2.271**	2.470*	-0.039	-0.115**	-0.041	0.898***
	(0.389)	(0.299)	(0.829)	(1.120)	(1.395)	(0.132)	(0.051)	(0.238)	(0.141)
Control Variables	-0.311	0.388	0.333	2.485**	2.239*	-0.017	-0.012	0.187	1.000***
	(0.421)	(0.315)	(0.887)	(1.170)	(1.202)	(0.124)	(0.018)	(0.381)	(0.000)
Sub-Sample Size	76	76	68	69	66	68	66	66	66
				Children 6-12 Years-Old					
No Control Variables	0.317*	-0.101	1.052	1.945**	1.013	0.032	NA	0.019	0.331
	(0.172)	(0.298)	(0.907)	(0.977)	(0.905)	(0.197)		(0.205)	(0.284)
Control Variables	0.375***	-0.075	1.337	2.366**	1.287	0.145	NA	0.025	0.403
	(0.142)	(0.349)	(1.053)	(1.043)	(0.956)	(0.313)		(0.214)	(0.298)
Sub-Sample Size	165	165	151	155	153	151		153	153
				Children 13-18 Years-Old					
No Control Variables	0.394**	No Converge	-0.810	-0.251	0.372	-0.175***	NA	0.524	-0.349
	(0.163)		(1.079)	(1.185)	(1.208)	(0.066)		(0.324)	(0.361)
Control Variables	0.268	-0.280**	-0.958	0.233	0.923	No Converge	NA	0.690*	-0.412
	(0.305)	(0.112)	(0.816)	(1.227)	(1.408)			(0.369)	(0.462)
Sub-Sample Size	80	80	67	68	67	67		67	67
Total Sample Size	**376**	**359**	**327**	**334**	**109**	**327**	**109**	**329**	**329**

Standard errors account for clustering at the household level and all regressions use survey weights. Models with full control variables include controls for the child's gender, age in months, age in months squared, birth order position, and their parent's age and height. Ballot success is used to instrument for being in NZ in each regression.

* significant at 10%; ** significant at 5%; *** significant at 1%

TABLE 4: IV ESTIMATES OF EXPERIMENTAL IMPACT BY GENDER (IV Probit Marginal Effects for Outcomes (1) - (2), (6) - (8), Linear IV for Remainder)

	Very Good Parent-Rated Health	Much Better Health Since Last Year	Standardised Height For Age	Standardised Weight For Age	Standardised BMI For Age	Stunted Height for Age < 5th Pctile	Overweight BMI for Age 85 - 95th Pctile	Obese BMI for Age >= 95th Pctile
				Children 0-2 Years-Old				
Girls	-0.687	No Converge	5.35**	1.657	-5.751	No Converge	No Converge	-0.554***
	(0.458)		(2.639)	(2.006)	(3.834)			(0.145)
Boys	-0.817***	No Converge	1.598	-10.400	1.256	No Converge	No Converge	0.289
	(0.124)		(2.015)	(6.712)	(5.533)			(1.651)
Test of equal impact (p-value)	0.774		0.285	0.087	0.295			0.324
Sub-Sample Size	55		41	42	43			43
				Children 3-5 Years-Old				
Girls	No Converge	-0.151	1.161	1.441*	-0.100	No Converge	No Converge	No Converge
		(0.332)	(1.266)	(0.856)	(0.772)			
Boys	No Converge	0.454	-0.700	3.693*	5.333*	No Converge	No Converge	No Converge
		(0.486)	(1.473)	(2.172)	(3.095)			
Test of equal impact (p-value)		0.358	0.357	0.300	0.096			
Sub-Sample Size		76	68	69	66			
				Children 6-12 Years-Old				
Girls	0.456***	-0.187	1.823	3.685**	2.526	0.037	-0.116	0.667***
	(0.084)	(0.402)	(1.686)	(1.821)	(1.681)	(0.340)	(0.075)	(0.133)
Boys	0.304	0.010	0.996	1.389	0.367	0.218	0.335	-0.046
	(0.220)	(0.408)	(1.040)	(0.859)	(0.943)	(0.436)	(0.427)	(0.303)
Test of equal impact (p-value)	0.347	0.681	0.628	0.170	0.209	0.739	0.203	0.096
Sub-Sample Size	165	165	151	155	153	151	153	153
				Children 13-18 Years-Old				
Girls	0.467***	-0.263**	-0.422	-0.199	-0.084	No Converge	0.552	-0.623***
	(0.084)	(0.120)	(1.242)	(1.485)	(1.770)		(0.684)	(0.178)
Boys	-0.211	-0.284**	-1.433	0.640	1.841	No Converge	0.730	0.077
	(0.589)	(0.115)	(1.125)	(1.680)	(2.143)		(0.503)	(0.537)
Test of equal impact (p-value)	0.144	0.562	0.554	0.676	0.488		0.850	0.332
Sub-Sample Size	80	80	67	68	67		67	67
Total Sample Size	**300**	**321**	**327**	**334**	**329**	**151**	**220**	**263**

Standard errors account for clustering at the household level and all regressions use survey weights. All models include a control variable for the child's gender, age in months, age in months squared, birth order position, and their parent's age and height. Ballot success is used to instrument for being in NZ, both of which are interacted with the child's gender.

* significant at 10%; ** significant at 5%; *** significant at 1%

TABLE 5: CORRELATES OF HEALTH STATUS IN TONGA (Probit Marginal Effects for Outcomes (1) - (2), (6) - (9), OLS for Remainder)

	Very Good Parent-Rated Health	Much Better Health Since Last Year	Standardised Height For Age	Standardised Weight For Age	Standardised BMI For Age	Stunted Height for Age < 5th Pctile	Underweight BMI for Age < 5th Pctile	Overweight BMI for Age 85 - 95th Pctile	Obese BMI for Age >= 95th Pctile
Log Total Household Cash Income	-0.109***	-0.023	0.179**	-0.221**	-0.356***	-0.024	0.0105*	0.014	-0.0596*
	(0.041)	(0.051)	(0.085)	(0.099)	(0.097)	(0.021)	(0.006)	(0.030)	(0.036)
Log Total Household Own-Production	0.0572*	0.043	0.015	0.086	0.254*	-0.005	-0.011	0.005	0.035
	(0.030)	(0.050)	(0.138)	(0.076)	(0.138)	(0.030)	(0.007)	(0.018)	(0.046)
Log Distance from Nearest Doctor	0.001	0.085	0.052	-0.178*	-0.184	-0.014	0.00869*	-0.026	0.002
	(0.041)	(0.054)	(0.146)	(0.106)	(0.171)	(0.032)	(0.005)	(0.022)	(0.053)
Female Dummy	-0.109	-0.065	-0.117	0.284*	0.470**	0.057	-0.0260**	-0.035	0.149**
	(0.078)	(0.064)	(0.219)	(0.153)	(0.188)	(0.063)	(0.012)	(0.046)	(0.060)
Age in Months / 12	-0.049	-0.017	0.038	0.195**	0.108	-0.0404**	-0.00496*	0.045	-0.022
	(0.032)	(0.031)	(0.110)	(0.092)	(0.086)	(0.020)	(0.003)	(0.031)	(0.034)
Age Squared / 144	0.002	0.001	-0.007	-0.00911**	-0.003	0.00305***	0.000331**	-0.002	0.002
	(0.002)	(0.002)	(0.006)	(0.004)	(0.004)	(0.001)	(0.000)	(0.001)	(0.002)
Birth Order Position	0.009	-0.013	0.260**	0.211**	0.086	-0.0561*	-0.009	-0.051	0.020
	(0.041)	(0.035)	(0.123)	(0.101)	(0.119)	(0.030)	(0.006)	(0.034)	(0.036)
Number of Children in Household	-0.009	-0.012	-0.083	-0.022	0.018	0.031	-0.003	0.023	-0.033
	(0.032)	(0.034)	(0.092)	(0.063)	(0.088)	(0.022)	(0.004)	(0.021)	(0.033)
Lives with Both Parents	0.048	0.367***	-0.253	-0.634**	-0.418	0.176***	Perfect	-0.204*	0.170
	(0.146)	(0.072)	(0.330)	(0.311)	(0.477)	(0.030)	Predictor	(0.114)	(0.148)
Father's Age	-0.001	-0.018	-0.031	-0.029	-0.016	-0.001	-0.001	-0.0165**	0.006
	(0.011)	(0.014)	(0.033)	(0.022)	(0.029)	(0.007)	(0.001)	(0.007)	(0.011)
Mother's Age	0.011	0.017	0.059	0.033	-0.005	-0.007	0.001	0.009	-0.003
	(0.010)	(0.014)	(0.038)	(0.032)	(0.036)	(0.008)	(0.001)	(0.007)	(0.012)
Father's Years of Education	0.0494*	0.026	-0.149**	-0.139**	-0.053	-0.005	0.005	-0.0374**	-0.017
	(0.029)	(0.031)	(0.074)	(0.056)	(0.084)	(0.019)	(0.004)	(0.018)	(0.033)
Mother's Years of Education	0.022	-0.027	0.112	0.216***	0.114	-0.006	-0.007	0.021	-0.002
	(0.024)	(0.024)	(0.094)	(0.054)	(0.102)	(0.022)	(0.005)	(0.013)	(0.034)
Father's Height	0.000	0.001	0.000	-0.00462**	-0.00567**	0.001	0.000	-0.00142***	0.000
	(0.001)	(0.002)	(0.003)	(0.002)	(0.002)	(0.001)	(0.000)	(0.000)	(0.001)
Mother's Height	-0.00371*	0.002	0.002	0.00561**	0.00649*	0.001	0.000	0.001	0.007
	(0.002)	(0.002)	(0.005)	(0.003)	(0.004)	(0.001)	(0.001)	(0.001)	(0.006)
Constant			-2.661	0.140	1.510				
			(1.932)	(1.365)	(1.890)				
Observations	417	393	356	374	366	356	344	366	366
R-squared	0.10	0.07	0.09	0.23	0.17	0.13	0.31	0.14	0.13

Robust standard errors in parentheses, Clustered at Household Level

* significant at 10%; ** significant at 5%; *** significant at 1%

TABLE 6: CORRELATES OF HEALTH STATUS IN NEW ZEALAND (Probit Marginal Effects for Outcomes (1) - (2), (6) - (7), OLS for Remainder)

	Very Good Parent-Rated Health	Much Better Health Since Last Year	Standardised Height For Age	Standardised Weight For Age	Standardised BMI For Age	Overweight BMI for Age 85 - 95th Pctile	Obese BMI for Age >= 95th Pctile
Change in Total Household Earnings	0.000	-0.0354**	-0.021	-0.006	0.004	-0.0111**	-0.002
(00s NZD)	(0.000)	(0.017)	(0.021)	(0.038)	(0.041)	(0.005)	(0.014)
Months in New Zealand / 12	0.012	0.220	0.306	0.222	0.060	-0.027	0.067
	(0.015)	(0.231)	(0.267)	(0.299)	(0.340)	(0.056)	(0.129)
Female Dummy	0.004	0.216	0.080	0.177	-0.105	-0.053	-0.058
	(0.005)	(0.135)	(0.253)	(0.220)	(0.317)	(0.073)	(0.129)
Age in Months / 12	0.000	0.094	-0.231	0.066	0.113	-0.005	-0.010
	(0.001)	(0.075)	(0.157)	(0.213)	(0.163)	(0.028)	(0.058)
Age Squared / 144	0.000	-0.001	0.008	0.000	0.000	0.001	0.004
	(0.000)	(0.003)	(0.007)	(0.009)	(0.007)	(0.001)	(0.003)
Birth Order Position	0.003	-0.192**	0.053	0.019	0.004	-0.011	-0.041
	(0.004)	(0.092)	(0.201)	(0.214)	(0.216)	(0.054)	(0.088)
Number of Children in Household	-0.001	0.250**	-0.308**	-0.062	0.125	-0.005	0.025
	(0.002)	(0.117)	(0.128)	(0.178)	(0.198)	(0.037)	(0.062)
Lives with Both Parents	Perfect	Perfect	1.424***	1.966***	1.973***	Perfect	0.287**
	Predictor	Predictor	(0.316)	(0.492)	(0.513)	Predictor	(0.123)
Father's Age	-0.001	-0.0880***	0.0771*	-0.032	0.006	-0.011	0.020
	(0.001)	(0.032)	(0.039)	(0.091)	(0.088)	(0.012)	(0.032)
Mother's Age	0.002	0.037	-0.005	-0.038	-0.099	0.013	-0.0471*
	(0.003)	(0.028)	(0.049)	(0.054)	(0.070)	(0.013)	(0.026)
Father's Years of Education	-0.001	-0.033	-0.033	0.017	-0.034	-0.0213**	-0.013
	(0.002)	(0.056)	(0.043)	(0.040)	(0.052)	(0.009)	(0.021)
Mother's Years of Education	0.002	0.052	-0.043	0.186*	0.151	-0.0352**	0.056
	(0.002)	(0.059)	(0.063)	(0.096)	(0.110)	(0.017)	(0.042)
Father's Height	0.000	-0.001	0.000	0.00549**	0.002	0.000	0.000
	(0.000)	(0.002)	(0.002)	(0.003)	(0.003)	(0.001)	(0.001)
Mother's Height	0.000	0.0485**	0.00434*	0.004	0.003	0.00804***	-0.001
	(0.000)	(0.021)	(0.002)	(0.003)	(0.004)	(0.003)	(0.001)
Constant			-1.881	-2.373	-0.689		
			(1.748)	(2.621)	(2.361)		
Observations	111	108	104	102	98	95	98
R-squared	0.62	0.38	0.26	0.26	0.26	0.15	0.16

Robust standard errors in parentheses, Clustered at Household Level (7 individuals are stunted and 1 underweight)

* significant at 10%; ** significant at 5%; *** significant at 1%

TABLE 7: IV ESTIMATES OF EXPERIMENTAL IMPACT ON DIET COMPOSITION (IV Probit Marginal Effects for Outcome (8), Linear IV for Remainder)

	# of Meals Rice	# of Meals Roots	# of Meals Fruits / Vegs	# of Meals Fish	# of Meals Fats	# of Meals Meats	# of Meals Milk	Anyone Eat Sweets
Mean Unsuccessful Ballots	0.195	1.592	3.414	0.538	0.793	0.911	0.124	0.024
Relative Price (Pa'anga / NZD)	1.966	0.504	0.769	0.567	0.654	1.262	1.657	NA
No Control Variables	0.019	0.856	-1.634	-0.188	0.670	1.645***	1.831***	0.510
	(0.265)	(0.554)	(1.194)	(0.326)	(0.484)	(0.444)	(0.308)	(0.440)
Control Variables	0.124	1.056*	-2.242*	-0.078	0.609	1.463***	1.862***	0.911***
	(0.261)	(0.569)	(1.284)	(0.317)	(0.459)	(0.449)	(0.300)	(0.157)
Total Sample Size	**377**	**377**	**377**	**377**	**377**	**377**	**377**	**377**

Standard errors account for clustering at the household level and all regressions use survey weights. Models with full control variables include controls for the child's gender, age in months, age in months squared, birth order position, their parent's age and height, and day of the week fixed effects. Ballot success is used to instrument for being in NZ in each regression. The market exchange rate is 1.372 Pa'anga per NZD. Roots include taro (swamp taro), taro taruas (chinese taro), kumara (sweet potato), taamu/kape, yams, cassava/manioc, and potato. Fruits and vegetables include other vegetables, coconut (fresh and dry), banana, mango, pawpaw, and other fruits. Fish includes tinned fish and fresh fish. Fats include corned beef, mutton, and coconut (fresh and dry). Meats include corned beef, mutton, fresh beef, chicken, pork, and other meat (eg. sausage).

* significant at 10%; ** significant at 5%; *** significant at 1%