Adverse childhood experiences and school readiness outcomes: results from the Growing Up in New Zealand study

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ABSTRACT

AIM: The Center for Disease Control’s (CDC) Adverse Childhood Experiences (ACEs) have been associated with adverse health consequences in adults and children, but less is known about any association between ACE and early learning skills. We investigated the relationship between ACEs and objective preschool measures of skills using the Growing up in New Zealand (GUiNZ) cohort study (n=5,562; 2009–2015).

METHODS: We mapped standard ACE definitions to GUiNZ to determine the prevalence of ACEs. We performed regression analysis to investigate the association between ACEs and a range of outcome measures, including counting up to 10, counting down from 10, letter recognition, affective knowledge, name writing, number writing and delayed gratification.

RESULTS: Before entering primary school, 52.8% of GUiNZ children experienced at least one ACE. We found a dose-response relationship with seven of the eight tests. For example, after statistically adjusting for multiple potential confounders, for each one additional ACE, children were 1.12 times more likely to be unable to count up from 1–10 (95% Confidence Interval 1.04–1.19).

CONCLUSIONS: Awareness of the negative impact of ACEs on school readiness should aid in the development and prioritisation of prevention strategies to reduce the occurrence and impact of ACEs in children.

The Adverse Childhood Experiences (ACEs) Study¹ and subsequent research have shown that people exposed to a range of adverse childhood experiences are at greater risk of health problems.²–³ ACEs include exposure to maltreatment, witnessing violence, experiencing parental divorce, living with household members who abuse substances, having a history of incarceration or having mental illness.¹ Even after statistically adjusting for a range of socioeconomic and demographic factors, ACEs predict chronic health conditions and other indicators of poor health.⁴ More recently, research has established that exposure to ACEs is also associated with health conditions during childhood.⁵–⁷

One of the pathways between ACEs and health is hypothesised to be harmful biological responses to stress.⁸ These physiological effects include a range of changes in the nervous system⁹–¹⁰ that have behavioural implications, compromising the child’s memory and causing cognitive and attention problems that may impact on the child’s readiness for school. This suggests that we would expect ACEs to be associated with poor development of skills in children. While several studies have documented ACEs’ impact in adolescent children,¹¹–¹³ only a few studies have investigated skills and behavioural deficits in early childhood related to ACEs.
One study, which did look at outcomes in early childhood, used the Fragile Families and Child Wellbeing Study of children born between 1998 and 2000 in 20 urban cities in the US. It looked at the association between ACEs recorded in the first five years of life and academic skills and classroom behaviours (as reported by the child’s year 1 teacher in New Zealand). Researchers controlled for the child’s age and gender, the mother’s race and ethnicity, the mother’s education, the relationship status of the parents at the time of child’s birth, and household income. They found that ACEs were associated with poorer academic skills and behavioural problems during the final month of kindergarten (year 1 in New Zealand).

While in New Zealand, the terminology of ACEs has not been used as extensively, there are nonetheless a number of relevant studies on the subject from existing cohort studies. One study used the New Zealand Dunedin Multidisciplinary Health and Development Study to look at exposure to ACEs in a historic New Zealand cohort. Adults were asked to recollect the occurrence of ACEs during their childhood. Approximately 35% of their cohort reported zero ACEs while 15% reported four or more ACEs. While correlates to ACEs were ascertained in the previous cohort studies, we were unable to find publications correlating these measures with school readiness. Using data from a contemporary birth cohort in New Zealand, Growing Up in New Zealand, we have the opportunity to look at the association between ACEs and school readiness. GUiNZ collected data on eight standard measures related to primary school readiness. Based on previous literature we expected ACEs to be negatively correlated with all administered tests.

The present report contributes to the existing literature in two ways. First it documents ACEs in a contemporary and ethnically diverse New Zealand population. Secondly, it adds to the growing evidence that ACEs have broader implications than just health. We document the association between ACEs and very early childhood developmental problems, highlighting the importance of prioritising interventions to prevent the occurrence or mitigate the impact of ACEs on school readiness.

Methods

The Growing Up in New Zealand study is a contemporary longitudinal study tracking the development of 6,790 births in New Zealand. The GUiNZ cohort has been argued to be broadly generalisable to New Zealand’s current population of births. In addition, the study catchment area also included a mix of urban and rural home environments. Ethics for the GUiNZ study were approved by the Health and Disability Northern Y Committee (NTY 08/06/055). We restricted our sample to those who responded to the 54-month wave and were enrolled before the birth of the child to ensure that all relevant outcomes were observed, which reduced the sample to 5,562 children. We used all available GUiNZ study waves and instruments to find correlates to commonly investigated adverse childhood experiences (ACEs). The GUiNZ study collected data on eight ACEs. Three specific standard ACEs involving child sexual abuse were not specifically collected as part of the GUiNZ study. Figure 1 summarises the measurement of the eight ACEs using GUiNZ survey questions.

School readiness outcomes

Luria-Nebraska Hand Clap Test
The hand clap test measures inhibitory control and the ability to stay focused.

DIBELS Letter Naming Fluency Test
The DIBELS letter naming fluency test is correlated with reading level at the end of the first year of school. The Grade K/Benchmark 1 version was used with randomly ordered lower-case and upper-case letters.

Gift Wrapping Test
A test of the ability to delay gratification was adapted from the original Marshmallow Task by Ebbesen. Each child was requested to please not look or peek at the surprise while it was being wrapped for 60 seconds.

Affective Knowledge Test
A modified Affective Knowledge Task was administered by giving children six face cards and asking how the person in the face cards feels. The emotions portrayed were ‘happy’, ‘sad’, ‘scared’, ‘angry’, ‘surprised’, and ‘disgusted’.
Number and Name Writing Test

Children were asked to write their name on a sheet of paper and write some numbers on a sheet of paper. GUINZ study staff were trained to code the number and name writing tests according to a standard scoring protocol.29

Counting up from 1–10 and down from 10–1

Children were asked, “Please can you count up from 1 to 10?” and “Please can you count down from 10 to 1?”. The interviewer wrote down exactly what the child said, and a score was assigned based on the longest correct number sequence given by the child.

Statistical analyses

The total number of experienced ACEs for each child was calculated by the age of 54 months. There are a total of 60 survey questions from three waves of data collection from partners and mothers used to indicate the presence of the eight studied ACEs. For purposes of these analyses, missing data for any reason was coded in such a way as to not add information on the presence of the ACE. For example, for mothers who didn’t complete the nine-month questionnaire that requested drug use history, those two variables were ignored in the logic when assigning ACEs to the children leaving only data from the partner to be used to determine if the ACE was observed for the child.
To ensure the ACEs were antecedent to the outcomes being observed, all ACEs were developed from data collected prior to or simultaneous with collection of the outcome measures. While child outcomes were collected on the date of the examination, ACEs collected during the same wave had reference windows that were before the interview date, for example within the past four weeks. Logistic regression was used to evaluate the crude and multi-variable adjusted odds ratios describing the prediction of childhood developmental outcomes using the total number of ACEs as the main independent variable. For multi-variable adjusted regression models, the set of adjustment factors included: family income, New Zealand deprivation index of residence at time of pregnancy, mother’s age, mother’s education, child’s gender, single-parent status and child’s ethnicity. Child development outcomes were all coded as dichotomous variables to indicate low performance on each test. This is to aid comparisons across measures and also as a proxy for additional resources that might be needed to address children not ready for school entry. Analysis of variance and chi-square tests of independence were conducted as indicated. All analyses were completed using STATA version 15.0. Fully standardised coefficients were computed with the `listcoef` command.

**Results**

Adverse childhood experiences (ACEs) were common in this cohort. By the 54-month wave, 52.8% of all GUiNZ children had experienced at least one ACE and 2.6% experienced four or more. Emotional and physical abuse were the most common ACEs, and parent or partner incarceration was the least common (Table 1).

ACEs experienced by GUiNZ children were consistently associated with family income, the New Zealand deprivation index at the time of enrolment, mother’s education, mother’s age and partner’s age (results not shown). For example, children with a family income <=20,000NZD experienced 3.02 times the number of ACEs than children with a family income of >150,000NZD. The disparity appears higher when looking at the percent with three or more ACEs. For example, children with a mother who reported no secondary qualification were 13.4 times more likely to have three or more ACEs, compared to children with mothers who reported having advanced degrees.

All investigated 54-month child evaluations were statistically significantly associated with both the total number of ACEs and both evaluated dichotomous variables indicating >=2 or >=3 experienced ACEs. Children who could recognise and name 0–1 letters in the DIBELS letter fluency test had, on average, 1.8 times as many ACEs, compared to children that named more than seven letters during the 60 seconds test (1.13 ACEs compared to 0.64 ACEs). Similarly, when focusing on the percentage of children who had >=3 ACEs, children who could recognise and name 0–1 letters on the DIBELS test were 3.64 times more likely to have >=3 ACEs compared to children who could name more than seven (14.2% compared to 3.9%). With a few minor exceptions, similar results were found throughout all investigated tests.

ACEs relationship with preschool readiness tests

Crude analyses showed statistically significant associations between the number of ACE exposures and child development tests administered as part of the GUiNZ study. For example, children with no ACEs had a mean DIBELS score of 9.6 letters in 60 seconds. The DIBELS score decreased as ACEs increased: 8.3 (1 ACE), 7.3 (2 ACEs), 4.7 (3 ACEs), 2.6 (4+ ACEs). Similar dose-response results can be found for all tests (data not shown). Figure 2 shows the percent at each number of ACEs that failed or performed in the bottom tertile of administered tests. For example, the percent in the bottom tertile of performance for the DIBELS test ranged from 24.4% (0 ACEs) to 55.7% (4+ ACEs).

After adjustment for possible confounders Table 2, most of these relationships declined in magnitude, but remained statistically significant. For example, after adjustment for potential confounders, for each additional experienced ACE, the difference in the log of expected counts of correctly identified letters decreased by 0.084 (95% Confidence Interval: 0.05–0.12). An additional interpretation is that an increase in one experienced ACE led to a reduction of 8.4% in the number of letters named. For
### Table 1: Percentages of Growing Up in New Zealand Child study participants experiencing adverse childhood experiences by the 54-month interview, New Zealand 2009–2015, n=5,562.

<table>
<thead>
<tr>
<th>Adverse childhood experience (ACE)</th>
<th>Percent of GUiNZ children experiencing ACE</th>
<th>Number of GUiNZ children experiencing ACE by 54 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child emotional abuse indicator</td>
<td>23.6%</td>
<td>1,310</td>
</tr>
<tr>
<td>Child physical abuse indicator</td>
<td>19.8%</td>
<td>1,101</td>
</tr>
<tr>
<td>Parent or partner indicator for illegal street drugs use</td>
<td>10.8%</td>
<td>601</td>
</tr>
<tr>
<td>Parent or partner indicator for depression</td>
<td>10.5%</td>
<td>584</td>
</tr>
<tr>
<td>Parent separation or divorce indicator</td>
<td>10.2%</td>
<td>569</td>
</tr>
<tr>
<td>Parent or partner intimate violence indicator</td>
<td>6.6%</td>
<td>366</td>
</tr>
<tr>
<td>Parent or partner indicator for problem drinker or alcoholic</td>
<td>4.5%</td>
<td>249</td>
</tr>
<tr>
<td>Parent or partner indicator for conviction and jail time</td>
<td>1.8%</td>
<td>99</td>
</tr>
<tr>
<td>Total adverse childhood experiences</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>47.2%</td>
<td>2,624</td>
</tr>
<tr>
<td>1</td>
<td>29.8%</td>
<td>1,657</td>
</tr>
<tr>
<td>2</td>
<td>14.5%</td>
<td>804</td>
</tr>
<tr>
<td>3</td>
<td>6.0%</td>
<td>334</td>
</tr>
<tr>
<td>4 or more</td>
<td>2.6%</td>
<td>143</td>
</tr>
</tbody>
</table>

### Table 2: Crude and multivariable* adjusted associations between 54-month child developmental outcomes and adverse childhood experiences (ACEs) in the Growing Up in New Zealand Study (n=5,562),^ New Zealand 2009–2015.

<table>
<thead>
<tr>
<th>Child developmental outcome</th>
<th>Sample size^</th>
<th>Mean (Std. Dev.)</th>
<th>Multivariable* Adjusted Estimated Scores</th>
<th>Multivariable* Adjusted Beta (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Luria Clapping Test Score</td>
<td>4,927</td>
<td>11.2 (5.0)</td>
<td>11.7 11.1 10.5 9.9</td>
<td>-0.03 (-0.04 to -0.01)</td>
</tr>
<tr>
<td>DIBELS Letter Naming Score</td>
<td>4,955</td>
<td>8.5 (10.5)</td>
<td>9.8 8.1 6.9 5.3</td>
<td>-0.08 (-0.12 to -0.05)</td>
</tr>
<tr>
<td>Affective Knowledge Test Score</td>
<td>5,073</td>
<td>7.9 (2.2)</td>
<td>8.1 7.9 7.6 7.4</td>
<td>-0.01 (-0.01 to 0.002)</td>
</tr>
<tr>
<td>Counting Up Test (1–10) Score</td>
<td>5,095</td>
<td>8.6 (2.9)</td>
<td>8.9 8.6 8.2 7.9</td>
<td>-0.01 (-0.025 to -0.003)</td>
</tr>
<tr>
<td>Counting Down Test (10–1) Score</td>
<td>5,095</td>
<td>4.1 (4.1)</td>
<td>4.6 4.0 3.4 2.9</td>
<td>-0.06 (-0.09 to -0.03)</td>
</tr>
<tr>
<td>Name Writing Test: percent pass</td>
<td>4,975</td>
<td>0.41 (0.49)</td>
<td>64.6% 58.4% 52.0% 45.4%</td>
<td>-0.07 (-0.13 to -0.01)</td>
</tr>
<tr>
<td>Number Writing Test: percent pass</td>
<td>4,827</td>
<td>0.62 (0.49)</td>
<td>41.3% 37.6% 34.2% 29.7%</td>
<td>-0.08 (-0.15 to -0.01)</td>
</tr>
<tr>
<td>Gift Wrapping Task: child didn’t peek</td>
<td>5,070</td>
<td>0.28 (0.45)</td>
<td>74.6% 71.9% 68.6% 66.1%</td>
<td>-0.08 (-0.15 to -0.02)</td>
</tr>
</tbody>
</table>

*Adjusted for family income, New Zealand deprivation index at time of pregnancy, mother’s age, mother’s education, child’s ethnicity, single parent (not cohabiting) status, and child’s gender.

^Due to missing responses or when the child did not complete an exam, sample sizes are lower than total participants.

**All p-values <0.05 except for the multivariable adjusted odds ratio for the Affective Knowledge Test.

Poisson regression was used for all scores and logistic regression for the dichotomous outcomes (percent pass or did not peek).
Figure 2: Percent of Growing Up in New Zealand children who were in the low performance categories for six school readiness tests by the number of adverse childhood experiences, New Zealand, 2009–2015.

All six tests had significant trend tests at the 95% confidence interval.
example, a child with 0 ACEs was modelled to have an expected number of correctly identified letters in 60 seconds of 9.8 and, as the number of ACEs increased, the expected number decreased; 9.8 (0 ACEs), 8.1 (1 ACE), 6.9 (2 ACEs), and 5.3 (3 ACEs). We tested for the possibility of different effects on ACEs on child development depending on the gender of the child and found no differences by gender in the results shown in Table 2 (data not shown).

Discussion

One of the considerable strengths of the GUiNZ study is the standardised early childhood tests administered by trained interviewers during the 54-month child interview. Based on previous literature we expected ACEs to be negatively correlated with all administered tests. Our results support this hypothesis, and provide evidence for a dose-response relationship between the number of ACEs a child is exposed to and their school readiness. As various cut points all indicated similar results, we focused on using the total number of ACEs as the main independent variable in logistic regression models predicting poor (bottom third) test performance.

ACEs were common among Growing Up in New Zealand (GUINZ) enrolled children. We found that, by the 54-month interview (when children were around 4½ years old), more than half of the enrolled children had experienced at least one ACE. However, without a complete registry of pregnant women, no sampling frame could be constructed nor could sampling weights be computed. Therefore, while our findings for this cohort might be broadly generalisable to New Zealand’s current population of births, additional details on response rates within subgroups would be required to get a better estimate of the prevalence of ACEs in New Zealand.

In addition, the GUINZ study did not ascertain sexual abuse and we used only data from the first 54 months to estimate ACE prevalences. We would expect the ACE prevalence estimates to be lower than other studies using all standard ACEs and through the 18 years of life. In the US 2010 Behavioural Risk Factor Surveillance Survey (BRFSS), 53,784 participants were interviewed. Researchers found 40.7% had not experienced an ACE compared with 47.2% of the GUINZ children. Without recreating the BRFSS ACE study on a representative sample of New Zealand adults, we are unable to make a direct comparison.

A number of ACEs were ascertained from responses from the partner surveys (eg, partner or partner depressed), and for 33.7% of GUINZ children the partner surveys were not collected. In these cases, we coded children where the partner had not responded the same as the absence of the ACE (eg, partner depression is coded the same if ‘not depressed’ or ‘partners survey missing’). This means that the gross estimates of ACEs from this study are lower than they would be with full data. Additional analyses are required to more fully understand the effect of missing data from the partners however, similar dose-response associations between ACEs and school readiness were found when excluding GUINZ children where a partner did not participate and including only measures of ACEs collected from the mother. As data missing due to partners not completing the survey are not at random, standard techniques to adjust (such as imputation) were not appropriate.

The observed associations between the GUINZ measures of school readiness and total ACEs experienced by children, even after controlling for common confounders, are noteworthy and add to the considerable literature on the negative effects of childhood toxic stress. These results highlight that potentially preventable ACEs could have a measurable effect on the skills of children about to enter primary school. Still, additional research could focus on which specific ACEs are most related to school readiness. Since we only focused on the observed presence of any given ACE we lose potentially informative data on the number of times each specific ACE was observed. In addition, GUINZ allows researchers the opportunity to look at the correlations between mother responses and partner responses on ascertainment of ACEs. While this was beyond the scope of this study, this information might prove of value if efficient ascertainment of ACEs in young children is required when providing services.

This report provides additional evidence on the association between early childhood ACEs and preschool objective measures of
early learning. There appears to be a clear dose-response association between experienced ACEs and measures often associated with readiness for starting primary school. The observed relationship between ACEs and school readiness should provide policy makers with New Zealand-specific data that could be used to support the prioritisation of prevention strategies to reduce the occurrence of ACEs in children and mitigate the negative outcomes found in this study. Educational policies that provide additional resources to schools with higher numbers of children who have experienced ACEs could also be considered. Additional research is required to focus on which ACEs may affect school readiness the most, and how dosage and frequencies of experiencing specific ACEs might correlate with school readiness.

Competing interests:
All authors report grants from New Zealand Ministry of Social Development (formally Superu) during the conduct of the study. Dr Maloney serves a part-time role as the chief economist at the Ministry of Social Development (MSD).

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