The Christchurch Health and Development Study: review of findings on child and adolescent mental health

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Objective: This paper provides an overview of the Christchurch Health and Development Study (CHDS) and a summary of findings relating to child and adolescent mental health.
Method: The CHDS is a longitudinal study of a birth cohort of 1265 children born in the Christchurch (New Zealand) urban region during mid 1977. This cohort has now been studied from birth to age 21.
Results: The paper examines the ways in which the study has been able to examine a wide range of issues. Key issues examined include: (i) measurement of disorder (respondent effects; dimensionality; scales *vs* categories); (ii) prevalence and treatment of disorder; (iii) stability and continuity of disorders; (iv) the contribution of risk and aetiological factors (e.g. lead exposure, parental divorce, child abuse, family adversity, sexual orientation) to psychosocial adjustment; and (v) the psychosocial consequences of mental health problems in adolescence.
Conclusions: The study findings illustrate the many advantages of a longitudinal study, such as the CHDS, in providing methodologically sound, theoretically relevant and cost effective research that caters for the interests of multiple end-users including the scientific community, clinicians and applied policy makers.
Key words: adolescence, childhood, longitudinal study, mental health.

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The Christchurch Health and Development Study (CHDS) is a longitudinal study of a birth cohort of 1265 children born in the Christchurch (NZ) urban region during mid 1977. This cohort has now been studied from birth to age 21 years with the data obtained from the study being used to address a wide range of issues relating to the social circumstances, health, development and wellbeing of the cohort. An important component of this research agenda has focused on the prevalence, development, aetiology and consequences of mental health and personal adjustment problems. The purpose of this article is to provide an overview of the findings of the CHDS as they relate to the development of mental health problems in the cohort. Key issues to be addressed include: (i) an overview of the design and data collection used in the CHDS; (ii) presentation and discussion of key results relating to the prevalence, development, aetiology and consequences of mental disorders in the cohort; and (iii) a brief consideration of the advantages of longitudinal designs such as the CHDS for examining issues relating to population mental health.

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Overview of research design

The CHDS uses a single cohort research design in which the same cohort of children has been studied at repeated intervals throughout its life course. Key features of the research design are outlined here.

Initial cohort

The initial cohort comprised all children born in the Christchurch urban region during the period from 15 April to 5 August 1977. During this period, a total of 1310 live births occurred and the parents of 1265 (97%) agreed to participate in the study.

Study times

Members of this cohort have now been assessed at birth, 4 months, 1 year, annual intervals to age 16, at 18 and 21.

Informants

Data collection in the CHDS has been based around a multiple informant design. The following data sources have been used during the course of the study: (i) parental interviews (birth–16 years); (ii) teacher questionnaires (6–13 years); (iii) child and young person interviews (8–21 years); (iv) hospital records (birth–16 years); and (v) Police record data (14–21 years). In all cases, data have been gathered on the basis of signed and informed consent from young people and/or their parents.

Data

The information gathered over the course of the CHDS comprises over 40 million characters of data describing the 21-year life history of the cohort. Key areas in which information was gathered have included: (i) prenatal and perinatal history; (ii) family social background; (iii) parental characteristics; (iv) family change and stability; (v) exposure to child abuse and family dysfunction; (vi) child health and health care utilization; (vii) educational achievement; (viii) behavioural adjustment at school; (ix) peer affiliations and relationships; (x) mental health and psychosocial adjustment in adolescence and young adulthood; and (xi) participation in tertiary education and the workforce.

Sample retention and bias

Rates of sample retention in the CHDS have been good and at each point of interview in the region of 98% of those studied at the previous interview have interviewed. Table 1 reports on the rates of sample retention at birth and ages 7, 14 and 21. It may be seen that by the age of 21, the sample had reduced to 1011 subjects who represented 80% of the original cohort. Sample losses over the course of the study have come from three major sources:

1. Outmigration from New Zealand: up to the age of 16 years subjects who migrated outside of New Zealand were treated as being no longer eligible for interview. This source accounted for 50% of all sample loss experienced by age 21.
2. Refusal to participate: the second source of loss has come from subject refusal to participate in the research, with this source of loss accounting for 37.4% of sample loss at age 21.
3. Mortality: mortality accounted for 9.8% of sample loss.
4. Failure to trace: sample losses due to failure to trace have been uncommon and at age 21 only 7 subjects (2.8% of sample losses) were not contacted.

An important issue raised by the sample losses described in Table 1 concerns the extent to which these losses have introduced a sample selection bias that may threaten the validity of the study. An advantage of the longitudinal design is that since the characteristics of subjects at the first point of observation are known, it becomes possible to conduct extensive tests for possible sample bias. Application of these tests showed that at age 21, there were small but detectable biases for the sample to underrepresent young people from socially disadvantaged backgrounds characterized by such features as low parental education, low socioeconomic status and entry into a single parent family at birth.

In recent years, there has been a growing literature on methods for correcting biases introduced by sample losses in longitudinal designs [1,2]. These methods of correction

Table 1. Rates of sample retention at birth and 7, 14 and 21 years

Age	Number studied	% of original cohort (n = 1265)	Sources of sample loss			
			Overseas	Non-response	Death	Untraced
Birth	1265	100	0	0	0	0
7 years	1107	87.5	87	56	15	0
14 years	996	78.7	136	116	17	0
21 years	1011	79.9	127	95	25	7

have included: (i) the use of the sample selection hazard proposed by Heckman [3,4]; (ii) the use of missing data estimation methods [2]; and (iii) the use of sample weights to reweight the sample to correct for systematic sample loss [1]. Over the years, these methods have been used to examine the potential effects of sample selection bias in the CHDS on the validity of conclusions [5–9]. In all cases, it has been found that the conclusions drawn before and after correction for sample bias have been identical.

Findings on childhood and adolescent mental health

The CHDS has completed in the region of 100 research papers that, in various ways, address issues relating to childhood and adolescent mental health or adjustment. Within the scope of this review, it is clearly not feasible to review all of the study findings. The review below gives a selective account of CHDS findings, focusing on those believed to have particular scientific or clinical interest.

Measurement

The development of standardized diagnostic criteria for psychiatric disorders [10,11] without doubt marked a turning point in the history of modern psychiatry by providing psychiatrists with a clear and apparently objective method for diagnostic classification. However, this development also raised a number of important issues concerning the validity of symptom report data. As part of the work of the CHDS, considerable attention was focused on the analysis of behavioural symptom data during middle childhood. Work in this area focused on three key issues: respondent effects, dimensionality of disruptive behaviour disorders, and categories or dimensions.

Respondent effects

A research finding that had caused considerable concern in the area of childhood behavioural research was the observation that reports of behavioural problems provided by one source (e.g. parents) were often only modestly correlated with reports from another source (e.g. teachers) [12]. These modest cross-informant correlations were seen as a threat to the validity of child behaviour report data. One resolution to this issue was proposed in a series of CHDS papers that used longitudinal data and methods of structural equation modelling to separate informant effects from behavioural variance [13–17]. These analyses suggested that reports from a given source contained two types of variance: (i) variance reflecting variation in child behavioural tendencies; and (ii) variance specific to a given source of reporting. It was estimated that in the region of 40% of the variance in child behaviour reports reflected true variations in child behavioural tendencies [16].

Dimensionality of disruptive behaviour disorders

The development of DSM-III and subsequent classifications led to debates about the dimensionality of child behaviour problems. Two key debates arose. The first concerned the extent to which attention deficit hyperactivity disorder (ADHD) behaviours were distinct from conduct disorders (CDs). In a review of this issue Hinshaw [18] examined the extent to which conduct problems and attentional problems reflected the same or different behavioural domains. He concluded that, although the weight of evidence favoured the view that there were two factors, this matter still required further resolution. A subsequent paper from the CHDS addressed this issue using methods of structural equation modelling and suggested the presence of two distinct, albeit highly correlated ($r = 0.88$), factors, with one factor reflecting conduct problems and the other attentional problems [19,20]. The second debate concerned the extent to which oppositional defiant disorders (ODDs) were distinct from CDs, with some authors holding the view that ODD was a milder form of CD and other authors suggesting that CD and ODD were different domains of childhood behaviour [21–24]. This issue was examined using CHDS data and methods of structural equation modelling which suggested that ODD and CD were, in fact, different but highly correlated factors [25].

Categories or dimensions

The development of standardized diagnostic criteria led to widespread use of this approach as the preferred method of representing psychiatric symptoms. However, this approach was not entirely consistent with the pre-existing psychometric approach that had often treated psychiatric symptoms as reflecting underlying dimensional variables [26–29]. This led to a situation in which terms such as conduct disorder were used interchangeably to describe scale dimensions and a psychiatric diagnosis. To examine the issues raised by the use of categories or dimensions, data from the CHDS were used to compare the predictive validity of dimensional and categorical scoring of symptom data on childhood disruptive behaviours [30]. This analysis clearly supported the view that dimensional variables had superior predictive validity when compared with a diagnostic alternative.

Prevalence and treatment seeking

Irrespective of debates about whether symptoms should be represented as scales or categories, there is nonetheless considerable interest in the fraction of children who show symptoms of sufficient severity to merit clinical attention. To address this issue the CHDS has gathered longitudinal data on the rates of psychiatric disorder (defined by DSM-III-R and DSM-IV criteria) in the cohort. The trends in these data are summarized in Table 2 which shows the fraction of the cohort who at 15 and 18 years met criteria for anxiety disorders, mood disorders, conduct disorder and substance abuse/dependence disorders.

The results show that at age 15, approximately one-quarter of the cohort met DSM-III-R criteria for at least one disorder. Rates of disorder were significantly ($p < 0.001$) higher in females than males, with the predominant reason for this being the higher rates of internalizing disorders (anxiety, depression) among females.

By the age of 18 years, rates of disorder had increased so that in the region of 40% of the cohort met criteria for disorder. The increases in rates of disorder were predominantly due to increases in rates of internalizing disorders and substance-use disorders between 15 and 18 years. Further, although females had a slightly higher rate of disorder than males (45% *vs* 39%), this difference was no longer significantly different ($p > 0.05$).

The high rates of disorder reported in Table 2 naturally raise the issue of the fraction of young people who meet criteria for disorder who seek and obtain treatment for disorder. This issue has been examined in the cohort at both ages 15 and 18 years [31,32]. At both ages, it was found that less than one-quarter of those meeting criteria for disorder received any form of treatment or assistance. Treatment seeking was more common among those with mood disorders. Questioning at age 18 revealed that the major reasons for young people with psychiatric disorders failing to seek assistance were that they believed that they did not require treatment, they felt that the problem would resolve itself or they did not think to seek treatment [32]. Further analysis suggested that those most likely to seek treatment were those with high levels of impairment as a result of the disorder, those with mood disorders and those with a previous history of psychiatric contact [32].

Continuity and stability

One of the major analytic advantages of the longitudinal design is that this design makes it possible to examine patterns of continuity and change in behaviours over time. A number of CHDS studies have examined the ways in which various early onset behaviours, including conduct problems and attentional problems, are related to later developmental outcomes. One potentially important set of observations has led to what has become to be known as the dual pathway theory [33,34]. This theory evolved out of research aimed at examining the longer-term consequences of early attentional problems and early conduct problems on later developmental outcomes. It had been well documented that children with early disruptive behaviour patterns were at increased risks of later delinquency, substance abuse and school failure [35–43]. However, many of these earlier analyses had failed to take account of the correlation and comorbidity between conduct problems and attentional problems so that it was unclear whether the long-term sequelae of early disruptive behaviours were due to conduct problems, attentional problems or a combination of these factors. In a series of studies [33,44–48] the CHDS has produced results to suggest that early attentional problems and early conduct problems in isolation have quite different long-term developmental consequences. Specifically:

1. Early conduct problems in the absence of attentional problems are associated with increased risks of later delinquency and substance abuse, but are not associated with increased risks of later educational failure.

Table 2. Rates (%) of mental disorders in the Christchurch Health and Development Study cohort at 15 and 18 years

	15 years			18 years		
	Female	Male	Total	Female	Male	Total
Anxiety disorders	18.8	6.9	12.9	22.3	11.7	17.1
Mood disorders	9.2	3.3	6.3	26.5	9.7	18.2
Conduct disorder	3.4	6.5	5.0	1.7	7.9	4.8
Alcohol/illicit drug abuse/dependence	6.8	4.5	5.7	19.6	28.5	24.0
Any of the above	28.3	15.7	22.0	44.6	39.2	42.0

2. Early attentional problems in the absence of early conduct problems are associated with increased risks of school failure but not with increased risks of delinquency and substance use.
3. Children with both early conduct problems and early attentional problems are at increased risks of later delinquency, substance abuse and school failure.

These conclusions appear to be generally robust and have been replicated in the CHDS cohort using methods of structural equation modelling and categorical data analysis methods. The findings suggest the presence of parallel causal pathways in which early conduct problems are precursors of later externalizing and early attentional problems are precursors of later educational difficulties, with these pathways co-occurring as a result of the comorbidity between early conduct problems and early attentional problems.

Risk and aetiological factors

Perhaps the most important application of the longitudinal design is the ability of this design to examine the linkages between antecedent risk factors and consequent outcomes. In turn, this feature opens the way for both the development of causal models and tests of causal hypotheses using correlational data. A large amount of the research conducted by the CHDS has focused on the testing of causal hypotheses. A brief review of some of the major lines of research is discussed below.

Low level lead exposure and later cognitive outcomes

Although it had been known for a long time that lead at high levels of exposure could have devastating effects on the central nervous system, until the last two decades of the 20th century little was known about the effects of lead at so-called subclinical levels of exposure. However, pioneering research by Needleman and his colleagues [49] in Boston produced evidence to suggest that at levels of exposure that were previously believed to be safe, there was evidence of small but detectable deficits in childhood cognitive ability and attentional behaviour. These findings led to the development of a series of studies around the world aimed at examining the potentially harmful effects of subclinical lead exposures [50–54]. As part of the CHDS, data were gathered both on childhood dentine lead levels and measures of cognitive ability, school achievement and behavioural adjustment. The findings from this study produced conclusions that were generally consistent with those reported by Needleman and his colleagues to the extent that results suggested that children with mildly elevated lead levels showed small deficits in school achievement that were still evident at the age of 18 [5,7,55–57]. These deficits persisted when due allowance was made for a range of confounding factors supporting the conclusion that they were a result of a cause and effect association between low-level lead exposure and childhood cognitive ability and educational achievement.

Parental separation/divorce and child psychopathology

A major social change in the latter half of the 20th century was the marked increase in divorce, with estimates suggesting that up to 50% of children were exposed to the separation and/or divorce of their parents by the age of 16 years [58,59]. The longitudinal nature of the CHDS provided an ideal opportunity to explore the extent to which exposure to parental separation and/or divorce was a risk factor for later problems of adjustment [60,61]. This research suggested that while children whose parents separated were at increased risks of later internalizing and externalizing problems, much of this increased risk was due to factors that were present prior to parental separation or divorce. These factors included socioeconomic disadvantage, elevated rates of adverse life events and higher levels of interparental conflict. When these pre-separation or divorce events were taken into account, most of the associations between parental separation/divorce and child adjustment were explained. Nonetheless, even following such control, there were small tendencies for children exposed to parental separation to be at somewhat increased risks of later conduct problems, mood disorder and substance abuse [60].

Child abuse and mental health in adolescence

An issue that came to prominence in the latter quarter of the 20th century concerned the extent to which exposure to child abuse, including both sexual and physical abuse, was a factor that contributed to later mental health problems. As part of the CHDS, cohort members were questioned at age 18 and asked to provide accounts of their childhood exposures to both sexual abuse and physical abuse [62]. Analysis of these data led to conclusions that suggested that exposure to childhood sexual abuse (and particularly severe abuse) led to increased risks of depression, anxiety, conduct disorders, substance-use disorders and suicidal behaviours [63,64]. These associations persisted even after extensive control for confounding factors suggesting that exposure to sexual trauma in childhood was a factor that contributed to the individual's later susceptibility to psychiatric disorder.

Although physically harsh and abusive treatment during childhood was found to be associated with increased risks of later mental disorders, these associations were largely

explained by social and contextual factors that were associated with childhood physical abuse [65]. These factors included: social disadvantage, family dysfunction, impaired parenting and parental psychopathology.

The accumulative effects of adverse family factors

As a general rule, CHDS research into family factors such as parental separation or divorce and childhood physical abuse has suggested that the effects of specific risk factors in isolation on rates of childhood problems tend to be modest. However, it is often the case that family disadvantages and deficits are correlated so that children are not exposed to one adverse factor but many factors. These findings prompted us to examine the ways in which multiple adverse family factors may impact on individual risk. This analysis examined the family backgrounds of children who by the age of 15 had developed severe multiple problem behaviours including conduct problems, substance abuse, police contact and mental health problems [66,67]. Although these children comprised a small minority of the cohort (2.7%) they were a group who were likely to attract considerable professional and community attention. Examination of the life histories of these young people revealed that, almost invariably, they had experienced childhoods marked by multiple social and family disadvantages that spanned economic disadvantage, family dysfunction, impaired parenting and limited life opportunities. Analysis of family history data suggested that children in the 5% of the cohort exposed to the greatest childhood disadvantage/family dysfunction had risks of multiple problem behaviours that were over 100 times those of children in the most advantaged 50% of the cohort.

Sexual orientation and mental health

An issue that has aroused considerable controversy in psychiatric research has concerned the linkages between sexual orientation and mental health with strong claims being made that young people of gay, lesbian or bisexual sexual orientation are at increased risks of mental health problems and suicidal behaviours [68–72]. However, the absence of well-collected data supporting these claims led to considerable scepticism about whether sexual orientation was a risk factor for mental ill health and suicidality. Recently a number of studies have been published that provide increasing support for this hypothesis [69–71]. As part of the data collected on the CHDS, reports of sexual orientation were gathered at age 18 and 21. On the basis of this questioning, 2.6% of the CHDS cohort revealed gay, lesbian or bisexual (GLB) sexual orientation [73]. Analysis of the mental health history of this group revealed that they were at increased risks of a range of mental health problems that included depression, anxiety, conduct problems, substance abuse and suicidal behaviours. The GLB series had odds of disorder that were between 1.9 and 6.2 times higher than among the heterosexual series [73]. These associations persisted after control for potentially confounding childhood factors. The weight of the evidence clearly favours the view that GLB youth are an at-risk group for mental disorders and suicidal behaviours.

Other studies

In addition to the lines of aetiological research described above, data from the CHDS has been used to address a wide range of issues relating to the aetiology of mental health and adjustment problems. Other areas of note include research into unemployment and adolescent mental health [74–76]; the role of peer relations and affiliations in the development of crime and substance use [77–81]; the consequences of cannabis use/abuse for subsequent personal adjustment and the use of other illicit drugs [82–84]; the consequences of alcohol abuse for rates of crime and motor vehicle accidents [8,85,86]; the development of antisocial behaviour in females [87,88]; pregnancy, smoking and psychiatric adjustment in adolescence [89]; maternal age and child outcomes [90]; breastfeeding and cognitive and social development [91,92]; psychosocial outcomes of adoption [93,94]; and the effects of other aspects of family functioning on adolescent adjustment including parental alcohol problems [95], interparental violence [96] and entry into a stepfamily [97].

Research into the consequences of mental health problems

Although much of the work on the CHDS cohort has focused on the prevalence, development and risk factors for mental health problems, in a number of studies efforts have also been made to examine the consequences of mental health problems for other aspects of the individual's life.

Review of key findings

The development of suicidal behaviours

A series of studies of the CHDS cohort has examined the development of suicidal behaviours in the cohort including both suicidal ideation and attempts [32,98–100]. These studies have suggested that suicidal behaviours were relatively common with over one-quarter of cohort

members reporting suicidal thoughts by the age of 21 and nearly 8% making a suicide attempt. The availability of longitudinal data on the development of suicidal behaviours, from adolescence into young adulthood, provided an opportunity to examine the contribution of various risk factors to the development of suicidal behaviours [98]. These findings suggested a life course model of suicidal behaviours in which the individual's risk of developing suicidal thoughts or making a suicide attempt depended on his/her accumulative exposure to: (i) adverse and dysfunctional childhood circumstances; (ii) personality factors including neuroticism and novelty seeking; (iii) mental disorders, and particularly mood disorders; and (iv) exposure to adverse life events. Of these risk factors the development of mental disorders made the strongest contribution and this finding is consistent with other research that has suggested that among those making suicide attempts or dying by suicide, the great majority have a recognizable psychiatric disorder [101–103].

The longer-term consequences of early onset depression and anxiety

Work in progress is examining the extent to which young people who develop mood or anxiety disorders before the age of 16 are at increased risks of later disorders and/or impaired life opportunities. This work suggests that those with early onset depression or anxiety are an at-risk population for subsequent depression, anxiety, substance use, unemployment and educational underachievement. However, much of this elevated risk appears to reflect the fact that the risk factors (social disadvantage, family dysfunction, child abuse) associated with the development of early depression and anxiety are also related to increased risks of later substance use and impaired life opportunities. When due allowance is made for these confounding factors, early anxiety or depression proves to be unrelated to later substance use, unemployment or educational failure. However, there is evidence of a clear continuity in disorder in which those showing early onset disorder are at significantly increased risk of further episodes of anxiety and depression.

Conclusion

The examples above illustrate the ways in which a moderately large longitudinal study conducted over a protracted time period has the potential to examine a wide range of issues relating to the assessment and prevalence of disorder, treatment seeking, continuity and change in disorders, risk factors and aetiology, and the consequences of mental disorders. One of the major advantages of the design is its relative cost-efficiency since a large number of different topics may be examined within the framework of the longitudinal design. The knowledge gained in longitudinal studies tends to be accumulative with findings from earlier stages of research laying the foundations for future research. Further, there are several well-known conceptual and analytic advantages of the longitudinal design. These include (i) the ability of the longitudinal design to provide a natural history account of developmental sequences as they unfold over time; (ii) precision in the timing of the measurement of exposure to risk factors and the onset and offset of disorder; (iii) elimination of risks of recall bias in the assessment of risk factors in cases where risk factors are assessed prior to the onset of disorder; and (iv) the ability of longitudinal design to provide tests of causality based on temporal sequencing.

A feature of the longitudinal design that is often overlooked is the flexibility of this design to address emerging research themes and issues. A clear example of this process is the CHDS research into the effects of low-level lead exposure. This research was not planned at the inception of the study but rather arose from a combination of three factors that facilitated this line of research. The first of these factors was the increasing research interest in this topic that developed in the early 1980s. The second was the age of the cohort at the time these concerns emerged. At that time cohort members were beginning to shed their deciduous teeth and this gave us access to a non-invasive method of assessing lead burden via dentine lead estimates. The third feature was the availability of local expertise to assess dentine lead levels. These three factors combined to produce a situation in which the CHDS was well placed to investigate the associations between early lead exposure and intellectual development. The long-term design of the CHDS meant that it was possible to examine these consequences into late adolescence and early adulthood. Similar considerations have led to a number of recent lines of research including research into unemployment, youth suicide and cannabis use.

A second important feature of the longitudinal study is the capacity for such research to address the interests and needs of multiple consumer audiences. Although much of the work of the CHDS has addressed theoretical issues that are largely of interest to the scientific community, the study is playing an increasing role in providing inputs into social and health policies in New Zealand. Recent examples of such inputs include contributions to the development of guidelines for the management of issues relating to youth suicide [104], recommendations to Government Select Committees on Youth at Risk [105] and Cannabis [106], the publication of data on mental health issues directed at policy audiences

[32], and the development of a family support intervention (Early Start) designed to address the needs of children born into at-risk family environments [107,108].

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