Do social interactions explain ethnic differences in psychological distress and the protective effect of local ethnic density? Evidence from a cross-sectional study of 226,487 adults in middle-to-older age

Journal:	*BMJ Open*
Manuscript ID:	bmjopen-2013-002713
Article Type:	Research
Date Submitted by the Author:	11-Feb-2013
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Primary Subject Heading:	Epidemiology
Secondary Subject Heading:	Epidemiology, Public health, Sociology
Keywords:	MENTAL HEALTH, EPIDEMIOLOGY, PUBLIC HEALTH, SOCIAL MEDICINE

Do social interactions explain ethnic differences in psychological distress and the protective effect of local ethnic density? Evidence from a cross-sectional study of 226,487 adults in middle-to-older age

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KEYWORDS

MENTAL HEALTH; ETHNICITY; MULTILEVEL MODELLING; PUBLIC HEALTH; SOCIAL EPIDEMIOLOGY

WORD COUNT: 2721

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ABSTRACT

Background: A frequently proposed, but under-researched hypothesis is that ethnic density benefits mental health through increasing social interactions. We examined this hypothesis in 226,487 adults from 19 ethnic groups aged 45 years and older in Australia.

Methods: Multilevel logit regression was used to measure association with scores of 22+ on the Kessler scale of psychological distress. Self-reported ancestry was used as a proxy for ethnicity. Measures of social interactions included the number of times in the last week were: *i)* spent with friends or family participants did not live with; *ii)* talked to someone on the telephone; *iii)* attended meetings of social groups; and *iv)* how many people could be relied upon outside their home, but within one hour of travel. Own-group ethnic density was measured as a percentage for Census Collection Districts.

Results: Psychological distress was reported by 11% of Australians born in Australia. The risk of experiencing psychological distress varied among ethnic minorities and by country of birth (e.g. 33% for the Lebanese born in Lebanon, compared to 4% for the Swiss born in Switzerland). These differences remained after full adjustment. Social interactions varied between ethnic groups and were associated with lower psychological distress and ethnic density. Ethnic density was associated with reduced psychological distress for some groups. This association, however, was explained by individual and neighbourhood characteristics and not by social interactions.

Conclusion: Social interactions are important correlates of mental health, but do not explain ethnic differences of psychological distress, nor the protective effect of own-group density.

WHAT IS ALREADY KNOWN ON THIS SUBJECT?

Ethnic differences in mental health, and the reportedly protective influence of own group ethnic density, are largely unexplained in previous studies. Social interactions are widely hypothesised as a mechanism linking ethnic density with more favourable mental health, and may also explain ethnic differences more generally. However, few studies have empirically tested these hypotheses.

WHAT THIS STUDY ADDS?

In a large cohort of Australian adults in middle-to-older age, ethnic differences in mental health were not explained by four measures of social interactions. Protective associations between ethnic density and mental health were largely explained by individual-level socioeconomic characteristics, not social interactions.

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SUMMARY

Article Focus:

- Ethnic differences in mental health, and the reportedly protective influence of own group ethnic density, are largely unexplained in previous studies.
- Social interactions are widely hypothesised as a mechanism linking ethnic density with more favourable mental health, and may also explain ethnic differences more generally. However, few studies have empirically tested these hypotheses.
- We examined this hypothesis in 226,713 adults from 19 ethnic groups aged 45 years and older in Australia.

Key Messages:

- Ethnic differences in mental health persisted after full adjustment; they were not explained by four measures of social interactions, or other individual and neighbourhood characteristics.
- Protective associations between ethnic density and mental health were largely explained by individual-level socioeconomic characteristics, not social interactions.

Strengths and Limitations:

- Large samples allowed for stratification of ethnic groups to investigate differences in mental health, social interactions and ethnic density by country of birth
- The use of a very small geographical scale than in previous work allowed for the ascertainment of local 'pockets' of ethnic density, which would otherwise have been hidden if the study had been dependent upon larger spatial units
- Some of the remaining ethnic inequalities in mental health could be explained by systematic differences in the experience of racial discrimination which we were unable to control for

INTRODUCTION

It has been suggested that living in areas of higher own group ethnic density reduces the risk of psychological distress, with increased social support hypothesised to be one of the primary drivers [1, 2]. Only two studies, however, have been identified that have examined this proposition, one in the UK and another in the US, with equivocal results [3, 4]. More broadly, studies of ethnic density and mental health have been mostly based upon adolescents and adults of child-bearing age in European and North American datasets [3-11]. Few studies have been conducted on adults in middle to older age, and no research has been conducted in Australia, which is surprising when one considers that, of the 22.6 million population, over one quarter were born outside Australia [12] and 50% of whom originated from non-English-speaking countries [13].

Australian cities are some of the most ethnically diverse in the world [14] and often contain substantial residential clustering of ethnic groups [15-17]. Contrasting migration histories and residential patterns of ethnic groups means that one cannot assume association between ethnic density and mental health reported in Europe and North America generalises to the Australian context. Therefore, more research is required not only to further understand the mechanisms underlying ethnic density effects, but also to identify the extent that ethnic density may be beneficial to mental health in other ethnically diverse countries like Australia. In this paper we attempt to achieve both through analysis of a large number of ethnic groups and four measures of social interactions in an Australian cohort of adults.

METHOD

Study population

The 45 and Up study [18] is a large scale cohort of 266,848 residents aged 45 and over in NSW (the most populous state in Australia). A baseline questionnaire including a range of health and social issues was distributed to a random sample of adults listed in the Medicare Australia database between 2006 and 2009. Response to the questionnaire was 18%. The University of New South Wales Human Research Ethics Committee approved The 45 and Up Study. Further details including the baseline questionnaire are available to download from www.45andUp.org.au

Ethnicity status was derived from first responses to a question on self-reported ancestry ('*What is your ancestry?'*). Secondary responses to this question were not used in the definition of ethnicity. We focused on the 19 largest groups: Australian, English, Scottish, Welsh, Irish, Danish, French, Swiss, German, Dutch, Spanish, Italian, Greek, Polish, Maltese, Lebanese, Croatian, Indian, and Chinese. Large sample sizes allowed for stratification of each group by country of birth (assessed by the question '*in which country were you born?*') to address healthy-migrant effects. We retained all participants born in Australia (n=179,712), all participants of Australian ethnicity born outside Australia (n=1,336), and participants of non-Australian ethnic groups born in their ethnic-country of origin (n=33,739). Participants of non-Australian ethnic groups born elsewhere (i.e. not Australia or their ethnic-country of origin) were omitted from the sample (n=33,574) for substantive and practical reasons. Non-Australian ethnic groups born overseas and not in the ethnic-country of

origin were heterogeneous by definition, which made it difficult to meaningfully interpret any results for to these participants. Furthermore, in practical terms, the sample sizes of many of these groups were small, which also reduced the potential to draw reliable statistical inference. We also omitted all participants missing a postcode identifier (n=263) and those missing a valid outcome measure (n=7,011). Missing data for independent variables was resolved via imputation, retaining an overall sample size of n=226,487.

Psychological distress

We used the Kessler Psychological Distress Scale (K10) to evaluate mental health status [19, 20]. The K10 measures symptoms of psychological distress experienced over the past four weeks, including feeling tired for no reason, nervous, hopeless, restless, depressed, sad and worthless. Participants had five choices for each of the ten questions (none of the time =1, a little of the time =2, some of the time =3, most of the time =4, all of the time=5) and these were summed to give the overall score. We constructed a binary variable wherein a score of 22 or more identified participants with a high risk of psychological distress [21]. The K10 has been used in this binary manner, with 22 as the cut-point, in previous published analyses of The 45 and Up Study [22-24].

Other individual-level measures

Social interactions were measured using four questions from the shortened version of the Duke Social Support Index [25]. Three of the questions tested the number of times in the past week a participant: i) spent time with friends or family they did not live with; ii) talked to someone (friends, relatives or others) on the telephone; iii) attended meetings at social clubs or religious groups. The final question asked participants how many people outside their home, but within one hour travel-time, did they feel close to or could rely on. Previous work has constructed a composite indicator of social support from responses to these questions [26, 27], though we analysed each one separately in line with recent studies which have demonstrated that some are more important than others [28].

We also accounted for other individual-level variables (self-reported) which are known to correlate with mental health. These included: age, gender, physical activity, smoking status, Body Mass Index (BMI), highest educational qualifications, economic status, annual household income, couple status, and whether language(s) other than English were spoken at home.

Neighbourhood-level measures

This study used Census Collection Districts (CCD) to define neighbourhoods. With a mean of 225 residents [29], CCDs were the smallest geographical scale for which 2006 Census data was made available [30]. However, 9% of participants in The 45 and Up Study were missing a valid CCD. As nearly 100% had a postcode identifier, we assigned those missing a CCD with a pseudo-CCD according to the location of the population-weighted postcode centroid. Therefore, 100% of the

sample could be assigned neighbourhood measures and clustering within regression models could be operationalized at the CCD level.

We constructed the measure of own-group ethnic density from 2006 Census data. The number of people within a CCD pertaining to each participant's ethnic group was divided the total usual resident population. For example, Chinese participants (regardless of their country of birth) were assigned the percentage of the population in their CCD who self-identified as Chinese.

Other neighbourhood measures included local affluence and geographical remoteness. We used the Socio-Economic Index for Areas (SEIFA) 'Index of Relative Socio-Economic Advantage/Disadvantage' [31] to measure local affluence. This variable was expressed in percentiles; higher percentiles indicate more affluent areas. Geographical remoteness was measured using the 'Accessibility/Remoteness Index of Australia' (ARIA) [32]. ARIA is a score ranging from 0 to 15, with scores of 2.4 and over used to distinguish between urban and inner regions (<2.4) and rural or remote (>=2.4).

Statistical analysis

The study population was first assessed using descriptive statistics. Measures of ethnic density were mapped across NSW. To investigate ethnic differences in psychological distress, multilevel logistic regression was used to account for the clustering of participants within CCDs [33]. The sample was clustered within 11,621 CCDs (20 participants per CCD on average). CCDs accounted for 3.3% of the variation in psychological distress within a 'null' two-level multilevel model. A categorical variable identifying ethnic groups stratified by country of birth was fitted in this model, which was then adjusted for age and gender. We proceeded to test whether any ethnic differences in psychological distress remained significant after controlling for social interactions, other individual-level variables, local affluence and geographical remoteness. Multilevel logit regression was fitted to ethnic and country of birth-specific groups to investigate association between psychological distress and own-group ethnic density. To assess whether these associations could be explained by social interactions, we first tested the extent of correlation between each measure and own-group ethnic density using negative-binomial regression (to account for the skewed distribution of the social interaction variables). Social interactions were then fitted into the logit models, followed by individual-level variables, local affluence and geographical remoteness. Interaction terms were fitted to test for potential synergistic effects between ethnic density and other neighbourhood variables. Statistically significant associations were identified using the log-likelihood ratio test ($p < 0.05$). All analyses were conducted in STATA 12.

RESULTS

Figure 1 reports differences in the age- and gender-adjusted prevalence of psychological distress by ethnicity and country of birth. The rate of high psychological distress was 11% for Australians born in Australia. In comparison, this risk was far higher for some groups, for example, 33% for the Lebanese born in Lebanon, but much lower for others, such as the Swiss born in Switzerland at 4%.There was no consistent effect of migrant status on the risk of psychological distress. For example, the

prevalence of psychological distress among Croatians born in Croatia was 14.3% higher than their Australian born Croatian peers. In contrast, no substantive difference in the prevalence of psychological distress was reported among the Chinese, whether born in Australia (12.8%) or China (12.9%), and the Danish born in Australia had twice the risk of their Danish born contemporaries (10% to 5% respectively).

<Figure 1 here>

Table 1 reports the percentage of each ethnic and country of birth group within the lowest quartile of the four social interactions measures. Compared to their Australian-born peers, those born within their ethnic country of origin tended to be more prevalent in the lowest quartile of every measure of social interactions. For the variable denoting how many people a person felt they could rely on, within group differences were notably wide between the Australian-born and those born in the ethnic country of origin for the French (34.1%, 52%), Polish (37.8%, 51%), Lebanese (26.2%, 45.7%) and Chinese (32.8%, 56.7%).

Table 1: Ethnic and country of birth differences in social interactions; percentage in the lowest quartile for each measure of social interactions

Ethnic group, country of birth	N (%)	Social interactions			
		Less likely to spend time with friends/family	*Less likely to talk to someone*	*Less likely to go to social clubs*	*Few people can depend on*
Australia, Australia	61,848 (27.3)	35.9 (35.51, 36.30)	26.1 (25.72, 26.45)	42.1 (41.68, 42.51)	30.5 (30.10, 30.88)
Australian, Not Australia	1,383 (0.6)	37.9 (35.37, 40.54)	30.2 (27.85, 32.73)***	37.9 (35.37, 40.59)***	36.7 (34.15, 39.28)***
English, Australia	50,480 (22.3)	35.6 (35.16, 36.03)	25.5 (25.06, 25.86)*	41.3 (40.89, 41.80)*	30.1 (29.64, 30.49)
English, UK	16,356 (7.2)	41.4 (40.66, 42.21)***	28.5 (27.82, 29.24)***	43.9 (43.15, 44.73)***	37.9 (37.17, 38.71)***
Scottish, Australia	21,745 (9.6)	35.1 (34.47, 35.78)*	24.6 (24.06, 25.24)***	40.5 (39.86, 41.21)***	29.2 (28.57, 29.81)***
Scottish, UK	3,759 (1.7)	37.8 (36.28, 39.43)*	27.8 (26.32, 29.23)*	42.9 (41.28, 44.53)	35.8 (34.26, 37.37)***
Welsh, Australia	1,265 (0.6)	36.6 (33.99, 39.38)	25.0 (22.67, 27.51)	40.3 (37.58, 43.11)	30.0 (27.48, 32.58)
Welsh, UK	835 (0.4)	42.4 (39.06, 45.87)***	28.9 (25.89, 32.12)	44.6 (41.14, 48.05)	38.0 (34.68, 41.35)***
Irish, Australia	33,360 (14.7)	35.0 (34.52, 35.58)**	24.1 (23.58, 24.53)***	39.7 (39.20, 40.30)***	30.4 (29.91, 30.94)
Irish, Ireland	1,048 (0.5)	40.9 (37.89, 43.92)***	27.5 (24.90, 30.34)	36.7 (33.71, 39.69)***	36.3 (33.37, 39.25)***
Danish, Australia	695 (0.3)	36.4 (32.84, 40.09)	24.7 (21.58, 28.11)	37.7 (34.11, 41.46)*	30.2 (26.88, 33.74)
Danish, Denmark	178 (0.1)	49.0 (41.63, 56.43)***	34.2 (27.55, 41.57)*	55.3 (47.76, 62.56)***	42.3 (35.15, 49.78)***
French, Australia	1,195 (0.5)	37.9 (35.18, 40.77)	26.3 (23.78, 28.92)	44.1 (41.20, 46.95)	34.1 (31.46, 36.87)**
French, France	237 (0.1)	47.1 (40.76, 53.58)***	29.9 (24.30, 36.10)	53.4 (46.92, 59.85)***	52.0 (45.51, 58.36)***
Swiss, Australia	163 (0.1)	40.9 (33.48, 48.67)	23.5 (17.62, 30.70)	49.7 (41.86, 57.48)	34.5 (27.59, 42.20)
Swiss, Switzerland	224 (0.1)	49.6 (43.01, 56.23)***	35.8 (29.66, 42.36)***	51.1 (44.46, 57.77)***	45.1 (38.62, 51.76)***
German, Australia	9,894 (4.4)	36.1 (35.18, 37.11)	26.4 (25.49, 27.27)	41.4 (40.41, 42.41)	31.0 (30.12, 31.97)
German, Germany	2,073 (0.9)	48.0 (45.82, 50.19)***	35.4 (33.33, 37.54)***	50.6 (48.38, 52.79)***	45.8 (43.63, 47.99)***
Dutch, Australia	1,487 (0.7)	35.0 (32.61, 37.43)	27.8 (25.57, 30.11)	41.6 (39.09, 44.15)	31.2 (28.93, 33.65)
Dutch, Netherlands	2,451 (1.1)	40.8 (38.88, 42.85)***	30.7 (28.87, 32.57)***	42.4 (40.39, 44.43)	37.7 (35.78, 39.68)***
Spanish, Australia	316 (0.1)	40.8 (35.42, 46.36)	28.6 (23.72, 33.93)	46.6 (41.05, 52.22)	30.0 (25.15, 35.25)
Spanish, Spain	158 (0.1)	45.5 (37.82, 53.48)*	31.4 (24.55, 39.12)	53.9 (45.89, 61.72)**	47.3 (39.57, 55.25)***
Italian, Australia	3,259 (1.4)	35.5 (33.88, 37.18)	25.8 (24.33, 27.34)	41.2 (39.49, 42.93)	32.0 (30.42, 33.66)
Italian, Italy	1,922 (0.9)	37.4 (35.21, 39.62)	29.5 (27.48, 31.58)***	48.1 (45.84, 50.43)***	36.5 (34.36, 38.75)***
Greek, Australia	1,072 (0.5)	34.1 (31.36, 37.03)	21.2 (18.92, 23.75)***	44.0 (40.98, 47.03)	30.1 (27.44, 32.96)

Greek, Greece	696 (0.3)	38.6 (35.02, 42.39)	30.5 (27.14, 34.09)**	45.8 (42.01, 49.61)	44.4 (40.63, 48.14)***
Polish, Australia	1,111 (0.5)	39.0 (36.14, 41.91)*	28.7 (26.05, 31.41)	41.8 (38.86, 44.72)	37.8 (34.94, 40.70)***
Polish, Poland	471 (0.2)	47.5 (42.98, 52.12)***	38.7 (34.31, 43.27)***	46.4 (41.80, 51.06)	51.0 (46.37, 55.52)***
Maltese, Australia	675 (0.3)	35.0 (31.53, 38.66)	28.8 (25.49, 32.29)	41.1 (37.47, 44.93)	29.2 (25.94, 32.79)
Maltese, Malta	715 (0.3)	38.7 (35.19, 42.43)	30.1 (26.78, 33.57)*	38.9 (35.29, 42.59)	38.9 (35.31, 42.57)***
Lebanese, Australia	461 (0.2)	34.0 (29.83, 38.49)	23.5 (19.81, 27.54)	37.5 (33.16, 42.06)*	26.2 (22.35, 30.39)*
Lebanese, Lebanon	567 (0.3)	30.9 (27.24, 34.78)*	29.6 (25.99, 33.43)	41.4 (37.34, 45.56)	45.7 (41.56, 49.89)***
Croatian, Australia	218 (0.1)	37.3 (31.12, 43.93)	22.9 (17.83, 28.92)	44.9 (38.34, 51.74)	34.3 (28.32, 40.93)
Croatian, Croatia	349 (0.2)	43.4 (38.20, 48.74)**	40.8 (35.63, 46.14)***	47.3 (42.00, 52.68)	48.0 (42.75, 53.36)***
Indian, Australia	213 (0.1)	39.0 (32.60, 45.72)	20.8 (15.90, 26.69)	43.6 (36.97, 50.42)	32.3 (26.38, 38.90)
Indian, India	668 (0.3)	47.7 (43.91, 51.61)***	26.3 (23.12, 29.66)	26.5 (23.29, 29.88)***	39.4 (35.66, 43.18)***
Chinese, Australia	690 (0.3)	39.3 (35.68, 43.03)	28.7 (25.41, 32.24)	40.5 (36.80, 44.23)	32.8 (29.36, 36.41)
Chinese, China	2,250 (1.0)	53.5 (51.40, 55.62)***	40.5 (38.42, 42.57)***	42.5 (40.42, 44.59)	56.7 (54.62, 58.82)***

*** p < 0.001; ** p < 0.01; * p < 0.05

Table 2 reports results from multilevel logit regression. Model 1 reports ethnic and country of birth differences in psychological distress, adjusted for age and gender (sensu Figure 1). We adjusted this Model for each social interaction variable individually, and then simultaneously (Model 2). Higher quartiles of each social interaction variable were associated with a lower risk of psychological distress; especially that denoting the number of people that can be relied on (highest quartile odds ratio: 0.36, 95% confidence interval: 0.34, 0.38). However, social interactions only explained the higher risk of psychological distress experienced by the Chinese born in China. Adjusting for all other individual-level characteristics, neighbourhood affluence and geographical remoteness (Model 3) had a more substantive effect on the ethnic differences (e.g. OR=3.67 to 2.11 for the Lebanese born in Lebanon).

Table 2: Ethnic and country of birth group differences in the risk of psychological distress, adjusted for social interactions variables and other individual and neighbourhood characteristics

Ethnicity, country of birth	Model 1	Model 2	Model 3
	Odds Ratio (95% Confidence Interval)		
Australian, Australia	1	1	1
Australian, Not Australia	1.83 (1.59, 2.10)***	1.73 (1.50, 1.99)***	1.57 (1.36, 1.82)***
English, Australia	0.93 (0.90, 0.97)***	0.94 (0.90, 0.98)***	0.96 (0.92, 1.00)*
English, UK	0.83 (0.78, 0.88)***	0.75 (0.71, 0.80)***	0.82 (0.77, 0.87)***
Scottish, Australia	0.89 (0.84, 0.93)***	0.90 (0.86, 0.95)***	0.96 (0.91, 1.01)
Scottish, UK	0.81 (0.72, 0.90)***	0.76 (0.68, 0.85)***	0.82 (0.73, 0.92)***
Welsh, Australia	1.10 (0.93, 1.31)	1.12 (0.94, 1.33)	1.19 (1.00, 1.42)
Welsh, UK	0.82 (0.65, 1.04)	0.75 (0.60, 0.95)*	0.84 (0.66, 1.07)
Irish, Australia	0.95 (0.91, 0.99)*	0.96 (0.92, 1.01)	0.99 (0.95, 1.04)
Irish, Ireland	0.93 (0.76, 1.13)	0.87 (0.71, 1.06)	0.92 (0.75, 1.12)
Danish, Australia	0.90 (0.70, 1.15)	0.91 (0.71, 1.17)	0.94 (0.73, 1.21)
Danish, Denmark	0.43 (0.22, 0.84)*	0.36 (0.18, 0.71)**	0.38 (0.19, 0.77)**
French, Australia	1.04 (0.87, 1.24)	1.01 (0.84, 1.21)	0.99 (0.83, 1.19)
French, France	1.08 (0.73, 1.60)	0.87 (0.58, 1.29)	1.00 (0.67, 1.51)
Swiss, Australia	1.01 (0.62, 1.65)	1.00 (0.61, 1.63)	1.14 (0.69, 1.88)
Swiss, Switzerland	0.33 (0.17, 0.65)***	0.27 (0.14, 0.53)***	0.33 (0.17, 0.65)***
German, Australia	1.12 (1.05, 1.19)***	1.11 (1.04, 1.19)***	1.10 (1.02, 1.17)**
German, Germany	0.98 (0.86, 1.13)	0.82 (0.71, 0.94)**	0.87 (0.75, 1.00)*
Dutch, Australia	1.03 (0.88, 1.22)	1.02 (0.87, 1.20)	1.07 (0.90, 1.27)
Dutch, Netherlands	0.96 (0.85, 1.09)	0.88 (0.78, 1.01)	0.91 (0.80, 1.04)
Spanish, Australia	1.08 (0.77, 1.52)	1.08 (0.76, 1.52)	0.92 (0.64, 1.33)
Spanish, Spain	1.35 (0.87, 2.11)	1.14 (0.73, 1.79)	1.06 (0.67, 1.67)

Italian, Australia	1.05 (0.94, 1.18)	1.04 (0.93, 1.17)	1.07 (0.96, 1.21)
Italian, Italy	1.79 (1.59, 2.02)***	1.68 (1.49, 1.89)***	1.46 (1.29, 1.65)**
Greek, Australia	1.07 (0.88, 1.29)	1.08 (0.89, 1.30)	1.11 (0.91, 1.35)
Greek, Greece	2.04 (1.69, 2.46)***	1.81 (1.50, 2.19)***	1.33 (1.10, 1.62)**
Polish, Australia	1.17 (0.98, 1.40)	1.10 (0.92, 1.32)	1.15 (0.95, 1.39)
Polish, Poland	1.89 (1.51, 2.37)***	1.54 (1.22, 1.94)***	1.64 (1.30, 2.08)***
Maltese, Australia	1.26 (1.01, 1.57)*	1.27 (1.01, 1.59)*	1.11 (0.88, 1.41)
Maltese, Malta	1.71 (1.41, 2.09)***	1.59 (1.30, 1.94)***	1.19 (0.97, 1.46)
Lebanese, Australia	1.13 (0.85, 1.50)	1.22 (0.92, 1.62)	1.31 (0.98, 1.75)
Lebanese, Lebanon	3.97 (3.30, 4.76)***	3.67 (3.04, 4.42)***	2.11 (1.73, 2.57)***
Croatian, Australia	0.97 (0.63, 1.49)	0.94 (0.61, 1.46)	1.00 (0.64, 1.56)
Croatian, Croatia	2.70 (2.11, 3.46)***	2.30 (1.78, 2.96)***	1.84 (1.42, 2.39)***
Indian, Australia	1.86 (1.31, 2.63)***	1.88 (1.33, 2.68)***	1.64 (1.14, 2.35)**
Indian, India	1.13 (0.89, 1.43)	1.07 (0.84, 1.36)	1.43 (1.12, 1.83)**
Chinese, Australia	1.18 (0.94, 1.48)	1.16 (0.92, 1.45)	1.18 (0.93, 1.50)
Chinese, China	1.19 (1.05, 1.35)**	0.90 (0.79, 1.02)	1.05 (0.92, 1.20)
Number of occasions spent with friends or family			
Quartile 1 (Low)		1	1
Quartile 2 (Low to Moderate)		0.77 (0.74, 0.81)***	0.78 (0.75, 0.82)***
Quartile 3 (Moderate to High)		0.80 (0.77, 0.83)***	0.78 (0.75, 0.81)***
Quartile 4 (High)		1.00 (0.97, 1.04)	0.89 (0.85, 0.92)***
Number of telephone conversations			
Quartile 1 (Low)		1	1
Quartile 2 (Low to Moderate)		0.77 (0.74, 0.80)***	0.82 (0.79, 0.85)***
Quartile 3 (Moderate to High)		0.79 (0.76, 0.82)***	0.83 (0.80, 0.87)***
Quartile 4 (High)		0.78 (0.75, 0.81)***	0.85 (0.82, 0.88)***
Number of visits to social clubs			
Quartile 1 (Low)		1	1
Quartile 2 (Low to Moderate)		0.75 (0.72, 0.78)***	0.86 (0.83, 0.90)***
Quartile 3 (Moderate to High)		0.77 (0.74, 0.80)***	0.88 (0.84, 0.91)***
Quartile 4 (High)		0.95 (0.92, 0.98)**	1.01 (0.97, 1.04)
Number of people that can be relied on			
Quartile 1 (Low)		1	1
Quartile 2 (Low to Moderate)		0.58 (0.56, 0.61)***	0.66 (0.63, 0.68)***
Quartile 3 (Moderate to High)		0.48 (0.47, 0.50)***	0.56 (0.54, 0.58)***
Quartile 4 (High)		0.36 (0.34, 0.38)***	0.44 (0.42, 0.46)***

* p < 0.05; ** p < 0.01; *** p < 0.001
Model 1: Multilevel logit regression, adjusted for age and gender
Model 2: Model 1 + social interactions
Model 3: Model 2 + other individual-level variables, neighbourhood affluence and geographical remoteness

Figure 2 illustrates the ethnic and country of birth group differences in own-group ethnic density. Regardless of whether participants were born in Australia or the UK, those identifying as Australian (32.6%) or English (35.1%) ethnicities lived in the most ethnically dense neighbourhoods. Compared to the Australians and the English, the clustering of other ethnic groups in NSW was much lower. The highest mean ethnic density for non-Australian and non-English groups was for the Chinese born in China at 14.9%, whereas the lowest was for Australian born Swiss at 0.1%. There was evidence of heterogeneity of mean ethnic density within some groups. For example, Italians born in Australia had a mean of ethnic density of 4.9% but Italian-born Italians had 7.7%. Similar patterns were observed for Greeks, the Chinese and the Lebanese.

<Figure 2 here>

For the next stage of analysis we investigated the level of association between psychological distress and own-group ethnic density. This necessitated stratification of the sample by ethnic and country of birth group to match each individual with the relevant ethnic density measure. For example, Chinese ethnic density was matched to Chinese individuals (irrespective of whether they were born in China or Australia). We conducted these analyses for all groups, but due to space constraints, we focus our report on groups that have a mean ethnic density of 2% or more: Australians, English, Scottish, Irish, German, Italian, Greek, Lebanese, and Chinese.

Table 3 reports the results of these ethnic and county of birth group specific models. Model 1 adjusted ethnic density for age and gender. Ethnic density appeared protective against psychological distress for the English born in UK, and Australian-born Scottish, Irish and Chinese. Unexpectedly, increasing ethnic density was associated with a higher risk of psychological distress among Australians born in Australia. This model was adjusted by the social interactions variables (Model 2), but the associations between ethnic density and psychological distress persisted. Further adjustment for other individual-level variables, local affluence and geographical remoteness (Model 3) had a much more substantive effect, with all ethnic density effects explained, except that for the English born in the UK and the overseas-born Australians. We did not find any evidence of interactions between ethnic density and any other independent variables in our models.

Table 3: Association between own-group ethnic density and psychological distress by ethnic group, adjusting for social interactions and other individual and neighbourhood characteristics: Odds Ratios (95% Confidence Intervals)

	Model 1	Model 2	Model 3
		OR (95% CI)	
Australian, Australia	1.01 (1.01, 1.01)***	1.01 (1.01, 1.01)***	1.00 (1.00, 1.00)
Australian, not Australia	0.97 (0.96, 0.99)***	0.98 (0.96, 0.99)**	0.97 (0.95, 0.99)**
English, Australia	1.00 (1.00, 1.00)	1.00 (1.00, 1.00)	1.00 (0.99, 1.00)
English, UK	0.99 (0.99, 1.00)*	0.99 (0.99, 1.00)*	0.99 (0.99, 1.00)*
Scottish, Australia	0.97 (0.94, 1.00)*	0.98 (0.95, 1.01)	0.99 (0.96, 1.01)
Scottish, UK	0.98 (0.91, 1.06)	0.99 (0.92, 1.07)	1.00 (0.93, 1.08)
Irish, Australia	0.98 (0.96, 0.99)**	0.98 (0.97, 1.00)**	1.00 (0.98, 1.01)
Irish, Ireland	0.94 (0.86, 1.03)	0.95 (0.86, 1.04)	0.97 (0.87, 1.07)
German, Australia	0.99 (0.95, 1.03)	0.99 (0.95, 1.04)	1.00 (0.96, 1.04)
German, Germany	1.00 (0.90, 1.11)	1.00 (0.90, 1.12)	1.00 (0.89, 1.12)
Italian, Australia	0.99 (0.97, 1.01)	0.99 (0.98, 1.01)	1.01 (0.99, 1.03)
Italian, Italy	1.00 (0.98, 1.01)	1.00 (0.99, 1.02)	1.00 (0.99, 1.02)
Greek, Australia	0.98 (0.94, 1.02)	0.99 (0.95, 1.04)	1.01 (0.96, 1.05)
Greek, Greece	1.01 (0.99, 1.03)	1.01 (0.99, 1.03)	1.01 (0.98, 1.03)
Lebanese, Australia	1.01 (0.95, 1.07)	1.04 (0.98, 1.10)	0.98 (0.91, 1.06)

Lebanese, Lebanon	1.02 (1.00, 1.05)	1.02 (1.00, 1.05)	1.01 (0.98, 1.04)
Chinese, Australia	0.90 (0.81, 0.99)*	0.86 (0.76, 0.97)*	0.88 (0.70, 1.12)
Chinese, China	1.00 (0.99, 1.01)	1.00 (0.99, 1.01)	1.00 (0.99, 1.01)

*** p < 0.05; ** p < 0.01; * p < 0.05

Model 1: Adjusted for age and gender

Model 2: Model 1 + social interactions

Model 3: Model 2 + individual characteristics, neighbourhood affluence and geographical remoteness

DISCUSSION

This paper examined the relationship between ethnic density and psychological distress in one of the most ethnic diverse areas of Australia. We found substantive heterogeneity in the risk of psychological distress between and within ethnic groups. Ethnic differences in social interactions, individual and neighbourhood characteristics did not explain the ethnic differences in the risk of psychological distress. More social interactions were associated with lower risk of psychological distress, especially the number of people study participants felt they could rely on. Increasing own-group ethnic density was associated with less psychological distress for some ethnic groups, but not all. Social interactions were often more common in ethnically dense neighbourhoods. However, individual and neighbourhood characteristics, not social interactions, explained the ethnic density effects on psychological distress. Only the English born in the UK and the overseas-born Australians appeared to benefit from ethnic density after controlling for all other characteristics.

Although there are many studies on ethnic density and mental health [1-11], only two others have tested whether this relationship is explained by social interactions. A UK study [3] found a lower risk of common mental disorders for the Irish and for the Bangladeshi groups they studied in more ethnically dense neighbourhoods. This was not fully explained by measures of practical and emotional social support. Contrary to the ethnic density hypothesis, this study also reported significantly higher risk of common mental disorders among white British in ethnically dense neighbourhoods. A study in the US [4] also showed the benefits of living in a higher own-ethnic group density neighbourhoods for the emotional well-being of Black and Hispanic groups. Measures of personal and neighbourhood social support partially explained the relationship for Blacks but not among Hispanics. Therefore, despite using contrasting measures of mental health and social interactions for different ethnic groups in the UK, US and Australia, our findings are consistent wherein social interactions only played a weak role in explaining the ethnic density effect on mental health.

A particular strength of our study includes the large sample sizes for many different ethnic groups; more than has been possible to analyse in previous studies [1]. This allowed stratification by country of birth, which afforded new insights into the heterogeneity of mental health, social interactions and ethnic density within ethnic groups. Our measures of psychological distress and social interactions have been widely validated. The small geographical scale (CCD) used to construct ethnic density provided a more accurate description of local circumstances than previous work which has relied upon larger spatial scales, helping to identify small 'pockets' of ethnic density and affluence that would otherwise have been hidden [34]. A limitation was that The 45 and Up Study was sampled

from the Medicare Australia database in which only includes Australian citizens and migrants on permanent residency visas. Migrants on temporary visas who are, by definition, ethnic minorities, were not represented in our study. Many studies have suggested that spatial variation in the experiences of racism could help to explain the ethnic density effect [7, 9]. Although we had no measure of racism in our study, virtually all benefits of ethnic density were already explained by other individual characteristics. Finally, our study represents only people 45 years and older, so it cannot discount the possibility of different patterns for younger age groups.

CONCLUSION

Ethnic groups in New South Wales, Australia, experience substantively different risks of psychological distress. These differences also align by country of birth, though there is no consistent pattern. Increasing social interactions, particularly those which help people to develop relationships with others they can depend on in times of need, are beneficial for mental health regardless of ethnicity and country of birth. In comparison, the ethnic density of where people live was protective only for the UK-born English and the overseas-born Australians.

ACKNOWLEDGEMENTS, COMPETING INTERESTS & FUNDING

We thank all of the men and women who participated in the 45 and Up Study. The 45 and Up Study is managed by the Sax Institute in collaboration with major partner Cancer Council New South Wales; and partners the Heart Foundation (NSW Division); NSW Ministry of Health; *beyondblue: the national depression initiative*; Ageing, Disability and Home Care, NSW Family and Community Services; and the Australian Red Cross Blood Service. We acknowledge the use of 2006 census and boundary data provided by the Australian Bureau of Statistics. To preserve the anonymity of participants in The 45 and Up Study, some parameters of the Census Collector District (CCD) level data cannot be reported. This location-indexing data from the 45 and up Study is highly restricted access and will be made available only through SURE (https://www.sure.org.au/).

The authors have no competing interests.

No funding was sought for this study.

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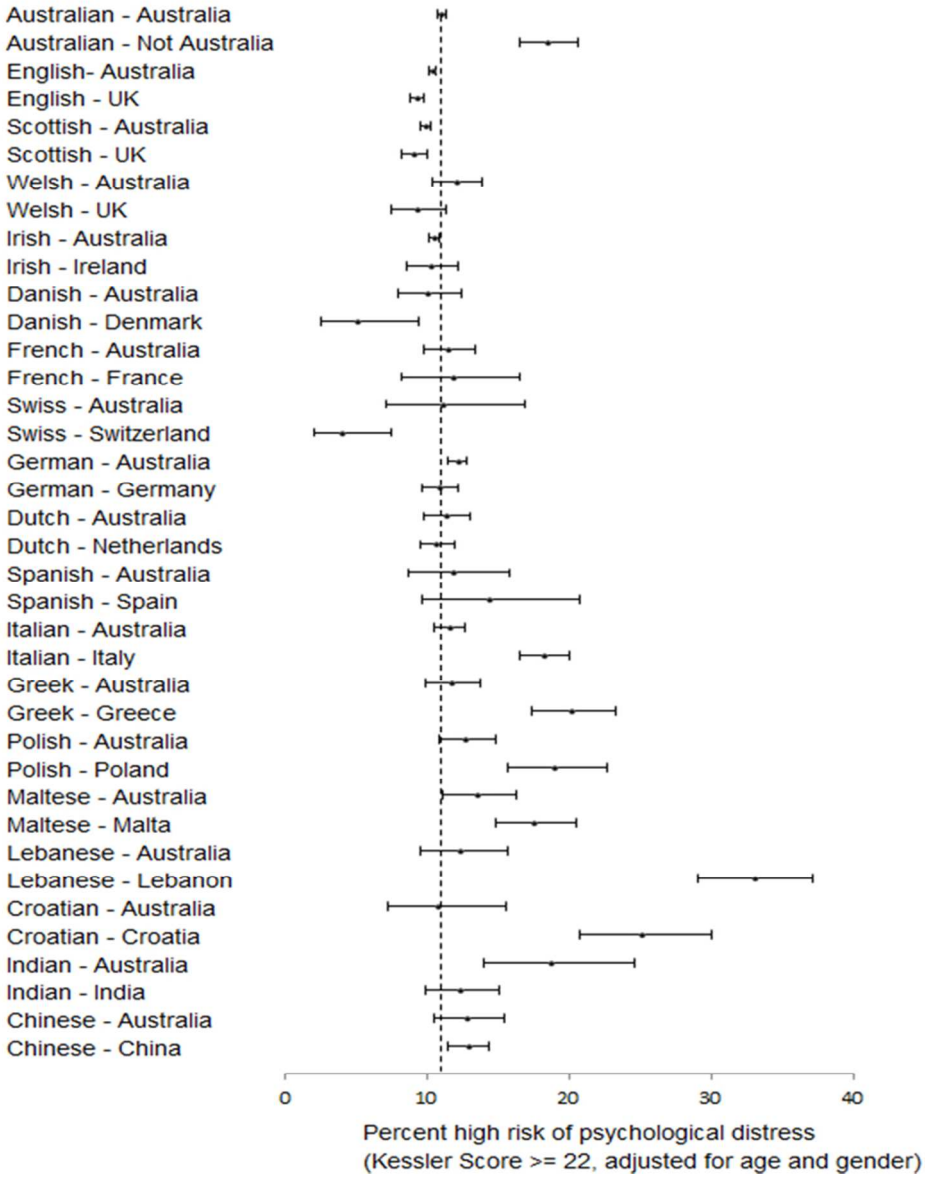

Figure 1: Ethnic and country of birth differences in the rate of psychological distress (Kessler scores of 22 and over), adjusted for age and gender
154x212mm (150 x 129 DPI)

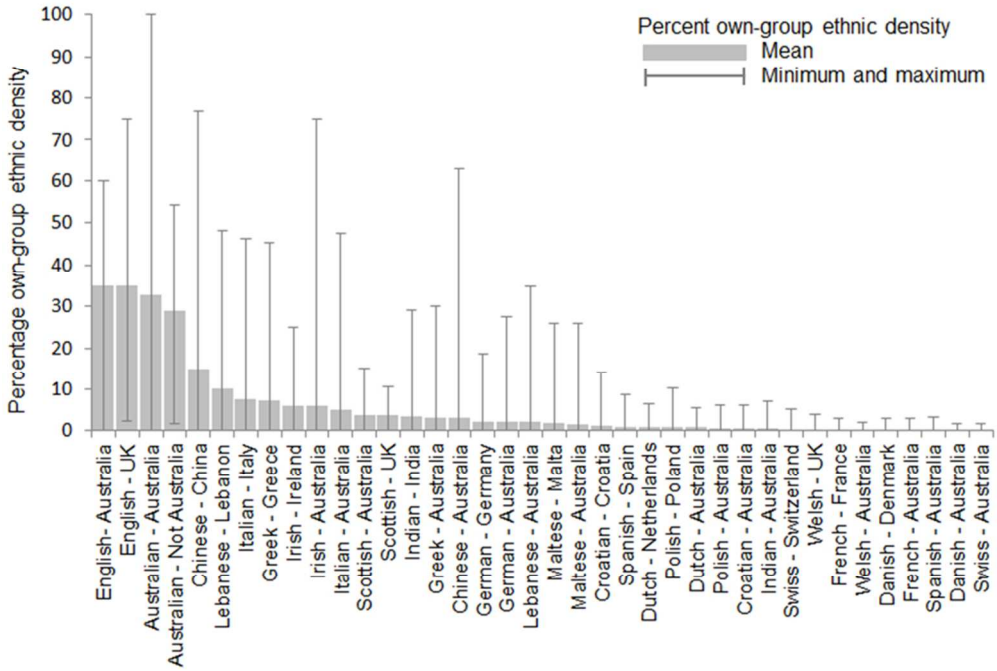

Figure 2: Ethnic and country of birth differences in mean own-group ethnic density (percentage) at the Census Collection District (CCD) scale, with minimum and maximum: sorted highest to lowest
254x179mm (96 x 96 DPI)

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Author comment and page number
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	We have indicated in the title that this is a cross-sectional study. (see page 1)
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	We have provided a structured abstract in line with JECH recommendations. (see page 1)
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	We have explained the scientific background and rationale for the study in a two-paragraph introduction. (see page2)
Objectives	3	State specific objectives, including any prespecified hypotheses	We outline the objective of the study in the second paragraph of the introduction, see page2.
Methods			
Study design	4	Present key elements of study design early in the paper	The study design is outlined in the first paragraph of the methods section, see page 2.
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	The setting is outlined in the second paragraph of the introduction and the first paragraph of the methods section, see page 2.
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	Eligibility criteria and the selection of participant is discussed in paragraph 1 and 2

			of the method section, see page 2 and 3
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	All variables are discussed in paragraphs 2-8 of the method section, see page 2-4
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	The primary source of data is the 45 and Up Study and this outlined in the first paragraph of the method section, see page 2. Details of measurement are provided separately for the outcome variable (psychological distress), other individual variables and neighbourhood level measures, see page 3.
Bias	9	Describe any efforts to address potential sources of bias	Sources of bias were discussed in the paragraph headed 'statistical analysis', see page4. This focuses on adjustment for confounders and for the hierarchical data structure though the use of multilevel models.
Study size	10	Explain how the study size was arrived at	Study size has been explained in paragraph 1 and 2of the method section, see page 2&3
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	All variables have been outlined in the method section, see page 3 & 4 for details.
Statistical methods	12	(*a*) Describe all statistical methods, including those used to	All methods have

		control for confounding	been described in the section headed 'statistical analysis', see page 4. Explanation on how missing data were addressed in paragraph 2 of the method section, see page 3.
		(*b*) Describe any methods used to examine subgroups and interactions	
		(*c*) Explain how missing data were addressed	
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Sample selection was described in paragraph 2 of the method section, see page 2 & 3.
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Characteristics of the study participants including sample sizes and prevalence of key outcome and explanatory variables are reported in paragraph 1-4 of the result section, see page 4 & 5, figure 1&2 and table 1 & 2.
		(b) Indicate number of participants with missing data for each variable of interest	
Outcome data	15*	Report numbers of outcome events or summary measures	
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Sub-group analysis is reported in paragraph 5 & 6 in the result section, see page 5 and table 3.
Discussion			
Key results	18	Summarise key results with reference to study objectives	Key results are outlined briefly in paragraph 1 of the discussion section on page 6.
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and	Strengths and limitations of the

		magnitude of any potential bias	study are discussed in paragraph 3 of the discussion section, see page 6 &7.
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Interpretation of the findings within the context of the previous literature is reported in paragraph 2 of the discussion, see page 6.
Generalisability	21	Discuss the generalisability (external validity) of the study results	
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	No funding was sought for this study.

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

Do social interactions explain ethnic differences in psychological distress and the protective effect of local ethnic density? Evidence from a cross-sectional study of 226,487 adults in middle-to-older age

Journal:	*BMJ Open*
Manuscript ID:	bmjopen-2013-002713.R1
Article Type:	Research
Date Submitted by the Author:	25-Mar-2013
Complete List of Authors:	Feng, Xiaoqi; University of Western Sydney, Centre for Health Research,School of Medicine Astell-Burt, Thomas; University of Western Sydney, School of Science and Health Kolt, Gregory; University of Western Sydney, School of Science and Health
Primary Subject Heading:	Epidemiology
Secondary Subject Heading:	Epidemiology, Public health, Sociology
Keywords:	MENTAL HEALTH, EPIDEMIOLOGY, PUBLIC HEALTH, SOCIAL MEDICINE

Do social interactions explain ethnic differences in psychological distress and the protective effect of local ethnic density? Evidence from a cross-sectional study of 226,487 adults in middle-to-older age

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KEYWORDS

MENTAL HEALTH; ETHNICITY; MULTILEVEL MODELLING; PUBLIC HEALTH; SOCIAL EPIDEMIOLOGY

WORD COUNT: 2721

Do social interactions explain ethnic differences in psychological distress and the protective effect of local ethnic density? Evidence from a cross-sectional study of 226,487 adults in middle-to-older age

ABSTRACT

Background: A frequently proposed, but under-researched hypothesis is that ethnic density benefits mental health through increasing social interactions. We examined this hypothesis in 226,487 adults from 19 ethnic groups aged 45 years and older in Australia.

Methods: Multilevel logit regression was used to measure association **between ethnicity, social interactions, own-group ethnic density and** scores of 22+ on the Kessler scale of psychological distress. Self-reported ancestry was used as a proxy for ethnicity. Measures of social interactions included the number of times in the last week were: *i)* spent with friends or family participants did not live with; *ii)* talked to someone on the telephone; *iii)* attended meetings of social groups; and *iv)* how many people could be relied upon outside their home, but within one hour of travel. **Per cent own-group ethnic density was measured at the Census Collection District scale.**

Results: Psychological distress was reported by 11% of Australians born in Australia. The risk of experiencing psychological distress varied among ethnic minorities and by country of birth (e.g. 33% for the Lebanese born in Lebanon, compared to 4% for the Swiss born in Switzerland). These differences remained after full adjustment. Social interactions varied between ethnic groups and were associated with lower psychological distress and ethnic density. Ethnic density was associated with reduced psychological distress for some groups. This association, however, was explained by individual and neighbourhood characteristics and not by social interactions.

Conclusion: Social interactions are important correlates of mental health, but do not **fully** explain ethnic differences in psychological distress, nor the protective effect of own-group density.

WHAT IS ALREADY KNOWN ON THIS SUBJECT?

Ethnic differences in mental health, and the reportedly protective influence of own group ethnic density, are largely unexplained in previous studies. Social interactions are widely hypothesised as a mechanism linking ethnic density with more favourable mental health, and may also explain ethnic differences more generally. However, few studies have empirically tested these hypotheses.

WHAT THIS STUDY ADDS?

In a large cohort of Australian adults in middle-to-older age, ethnic differences in mental health were not explained by four measures of social interactions. Protective associations between ethnic density and mental health were largely explained by individual-level socioeconomic characteristics, not social interactions.

Do social interactions explain ethnic differences in psychological distress and the protective effect of local ethnic density? Evidence from a cross-sectional study of 226,487 adults in middle-to-older age

SUMMARY

Article Focus:

- Ethnic differences in mental health, and the reportedly protective influence of own group ethnic density, are largely unexplained in previous studies.
- Social interactions are widely hypothesised as a mechanism linking ethnic density with more favourable mental health, and may also explain ethnic differences more generally. However, few studies have empirically tested these hypotheses.
- We examined this hypothesis in 226,713 adults from 19 ethnic groups aged 45 years and older in Australia.

Key Messages:

- Ethnic differences in mental health persisted after full adjustment; they were not explained by four measures of social interactions, or other individual and neighbourhood characteristics.
- Protective associations between ethnic density and mental health were largely explained by individual-level socioeconomic characteristics, not social interactions.

Strengths and Limitations:

- Large samples allowed for stratification of ethnic groups to investigate differences in mental health, social interactions and ethnic density by country of birth
- The use of a very small geographical scale than in previous work allowed for the ascertainment of local 'pockets' of ethnic density, which would otherwise have been hidden if the study had been dependent upon larger spatial units
- Some of the remaining ethnic inequalities in mental health could be explained by systematic differences in the experience of racial discrimination which we were unable to control for

INTRODUCTION

The existence of ethnic differences in mental health have long been reported, though not fully explained [1-3]. It has been suggested that living in areas of higher own group ethnic density reduces the risk of psychological distress, with increased social support hypothesised to be one of the primary drivers [4]. Social norms and support networks that promote resilience to material disadvantage and sources of psychosocial stress (e.g. racism [5]) are thought to be encouraged and maintained by this geographical clustering of ethnic groups [6]; even in deprived communities [7-9]. However, there is very little empirical evidence on the extent that increased social support explains why some groups tend to report better mental health in ethnically dense neighbourhoods.

Only two studies have been identified that have examined this proposition, one in the UK and another in the US, with equivocal results [10 11]. More broadly, studies of ethnic density and mental health have been mostly based upon adolescents and adults of child-bearing age in European and North American datasets [10-18]. Few studies have been conducted on adults in middle to older age, and no research has been conducted in Australia, which is surprising when one considers that, of the 22.6 million population, over one quarter were born outside Australia [19] and 50% of whom originated from non-English-speaking countries [20].

Australian cities are some of the most ethnically diverse in the world [21] and often contain substantial residential clustering of ethnic groups [22-24]. Contrasting migration histories and residential patterns of ethnic groups means that one cannot assume association between ethnic density and mental health reported in Europe and North America generalises to the Australian context. Therefore, more research is required not only to further understand the mechanisms underlying ethnic density effects, but also to identify the extent that ethnic density may be beneficial to mental health in other ethnically diverse countries like Australia. In this paper we attempt to achieve both of these aims, in addition to an examination of ethnic differences in mental health and the role of social support more generally, through an analysis of a large number of ethnic groups and four measures of social interactions in an Australian cohort of adults.

METHOD

Study population

The 45 and Up study [25] is a large scale cohort of 267,151 residents aged 45 and over in New South Wales ('NSW', the most populous state in Australia). A baseline questionnaire covering a range of health and social issues was distributed to a random sample of adults listed in the Medicare Australia database between 2006 and 2009 inclusive. Medicare Australia is the database through which national healthcare is provided for Australian citizens and permanent residents, as well some temporary residents and refugees [25]. Response to the questionnaire was 18%, which is low, though previous research has suggested that results from the 45 and Up Study are broadly comparable to those derived from 'representative' samples [26]. The University of New South Wales Human Research Ethics Committee approved The 45 and Up Study. Further details including the baseline questionnaire are available to download from www.45andUp.org.au.

Ethnicity status was derived from the first **(of up to two)** responses to a question on self-reported ancestry (‘*What is your ancestry?’*). Secondary responses to this question were not used in the definition of ethnicity as they were not available in our dataset. We focused on the 19 largest groups: Australian, English, Scottish, Welsh, Irish, Danish, French, Swiss, German, Dutch, Spanish, Italian, Greek, Polish, Maltese, Lebanese, Croatian, Indian, and Chinese. Large sample sizes allowed for stratification of each group by country of birth (assessed by the question ‘*in which country were you born?*’) to address healthy-migrant effects. We retained all participants born in Australia (n=179,712), all participants of Australian ethnicity born outside Australia (n=1,336), and participants of non-Australian ethnic groups born in their ethnic-country of origin (n=33,739). Participants of non-Australian ethnic groups born elsewhere (i.e. not Australia or their ethnic-country of origin) were omitted from the sample (n=33,574) for substantive and practical reasons. Non-Australian ethnic groups born overseas and not in the ethnic-country of origin were heterogeneous by definition, which made it difficult to meaningfully interpret any results for to these participants. Furthermore, in practical terms, the sample sizes of many of these groups were small, which also reduced the potential to draw reliable statistical inference. We also omitted all participants missing a postcode identifier (n=263) and those missing a valid outcome measure (n=7,011). Missing data for independent variables was resolved via **imputing the mean of the observed values**, retaining an overall sample size of n=226,487.

Psychological distress

We used the Kessler Psychological Distress Scale (K10) to evaluate mental health status [27 28]. The K10 measures symptoms of psychological distress experienced over the past four weeks, including feeling tired for no reason, nervous, hopeless, restless, depressed, sad and worthless. Participants had five choices for each of the ten questions (none of the time =1, a little of the time =2, some of the time =3, most of the time =4, all of the time=5) and these were summed to give the overall score. **The K10 have been previously used to gauge levels of psychological distress across different countries and ethnic groups [28-31].** We constructed a binary variable wherein a score of 22 or more identified participants with a high risk of psychological distress [32]. The K10 has been used in this binary manner, with 22 as the cut-point, in previous published analyses of The 45 and Up Study [33-35].

Other individual-level measures

Social interactions were measured using four questions from the shortened version of the Duke Social Support Index [36]. Three of the questions tested the number of times in the past week a participant: i) spent time with friends or family they did not live with; ii) talked to someone (friends, relatives or others) on the telephone; iii) attended meetings at social clubs or religious groups. The final question asked participants how many people outside their home, but within one hour travel-time, did they feel close to or could rely on. Previous work has constructed a composite indicator of social support from responses to these questions [37 38], though we analysed each one separately in line with recent studies which have demonstrated that some are more important than others [39].

We also accounted for other individual-level variables (self-reported) which are known to correlate with mental health. These included: age, gender, physical activity, smoking status, Body Mass Index (BMI), highest educational qualifications, economic status, annual household income, couple status, and whether language(s) other than English were spoken at home.

Neighbourhood-level measures

This study used Census Collection Districts (CCD) to define neighbourhoods. With a mean of 225 residents [40], CCDs were the smallest geographical scale for which 2006 Census data was made available [41]. However, 9% of participants in The 45 and Up Study were missing a valid CCD. As nearly 100% had a postcode identifier, we assigned those missing a CCD with a pseudo-CCD according to the location of the population-weighted postcode centroid. Therefore, 100% of the sample could be assigned neighbourhood measures and clustering within regression models could be operationalized at the CCD level.

We constructed the measure of own-group ethnic density from 2006 Census data. **The Census question on ancestry (a surrogate for ethnicity in our study) was very similar to that used in the 45 and Up Study ("What is the person's ancestry?").** The number of people within a CCD pertaining to each participant's ethnic group was divided the total usual resident population. For example, Chinese participants (regardless of their country of birth) were assigned the percentage of the population in their CCD who self-identified as Chinese.

Other neighbourhood measures included local affluence and geographical remoteness. We used the Socio-Economic Index for Areas (SEIFA) 'Index of Relative Socio-Economic Advantage/Disadvantage' [42] to measure local affluence. **This is a variable derived by the Australian Bureau of Statistics (ABS) using Census variables which relate to advantage and disadvantage, including household income and educational qualifications. This indicator** was expressed in percentiles; higher percentiles indicate more affluent areas. Geographical remoteness was measured using the 'Accessibility/Remoteness Index of Australia' (ARIA) [43]. ARIA is a score ranging from 0 to 15, with scores of 2.4 and over used to distinguish between urban and inner regions (<2.4) and rural or remote (>=2.4).

Statistical analysis

The study population was first assessed using descriptive statistics. Measures of ethnic density were mapped across NSW. To investigate ethnic differences in psychological distress, multilevel logistic regression was used to account for the clustering of participants within CCDs [44]. The sample was clustered within 11,621 CCDs (20 participants per CCD on average). CCDs accounted for 3.3% of the variation in psychological distress within a 'null' two-level multilevel model. A categorical variable identifying ethnic groups stratified by country of birth was fitted in this model, which was then adjusted for age and gender. We proceeded to test whether any ethnic differences in psychological distress remained significant after controlling for social interactions, other individual-level variables, local affluence and geographical remoteness. **Multilevel logit regression was fitted to ethnic and country of birth-specific groups (i.e. stratified models) to investigate association between**

psychological distress and own-group ethnic density. To assess whether these associations could be explained by social interactions, we first tested the extent of correlation between each measure and own-group ethnic density using negative-binomial regression (to account for the skewed distribution of the social interaction variables). Social interactions were then fitted into the logit models, followed by individual-level variables, local affluence and geographical remoteness. Interaction terms were fitted to test for potential synergistic effects between ethnic density and other neighbourhood variables. Statistically significant associations were identified using the log-likelihood ratio test ($p < 0.05$). All analyses were conducted in STATA 12.

RESULTS

Figure 1 reports differences in the age- and gender-adjusted prevalence of psychological distress by ethnicity and country of birth. The rate of high psychological distress was 11% for Australians born in Australia. In comparison, this risk was far higher for some groups, for example, 33% for the Lebanese born in Lebanon, but much lower for others, such as the Swiss born in Switzerland at 4%.There was no consistent effect of migrant status on the risk of psychological distress. For example, the prevalence of psychological distress among Croatians born in Croatia was 14.3% higher than their Australian born Croatian peers. In contrast, no substantive difference in the prevalence of psychological distress was reported among the Chinese, whether born in Australia (12.8%) or China (12.9%), and the Danish born in Australia had twice the risk of their Danish born contemporaries (10% to 5% respectively).

<Figure 1 here>

Table 1 reports the percentage of each ethnic and country of birth group within the lowest quartile of the four social interactions measures. **P-values for comparisons between ethnic and country of birth groups for each social interaction variable were calculated using logistic regression**. Compared to their Australian-born peers, those born within their ethnic country of origin tended to be more prevalent in the lowest quartile of every measure of social interactions. For the variable denoting how many people a person felt they could rely on, within group differences were notably wide between the Australian-born and those born in the ethnic country of origin for the French (34.1%, 52%), Polish (37.8%, 51%), Lebanese (26.2%, 45.7%) and Chinese (32.8%, 56.7%).

Table 1: Ethnic and country of birth differences in social interactions; percentage in the lowest quartile for each measure of social interactions

Ethnic group, country of birth	N (%)	Social interactions			
		Less likely to spend time with friends/family	*Less likely to talk to someone*	*Less likely to go to social clubs*	*Few people can depend on*
Australia, Australia	61,848 (27.3)	35.9 (35.51, 36.30)	26.1 (25.72, 26.45)	42.1 (41.68, 42.51)	30.5 (30.10, 30.88)
Australian, Not Australia	1,383 (0.6)	37.9 (35.37, 40.54)	30.2 (27.85, 32.73)***	37.9 (35.37, 40.59)***	36.7 (34.15, 39.28)***
English, Australia	50,480 (22.3)	35.6 (35.16, 36.03)	25.5 (25.06, 25.86)*	41.3 (40.89, 41.80)*	30.1 (29.64, 30.49)
English, UK	16,356 (7.2)	41.4 (40.66, 42.21)***	28.5 (27.82, 29.24)***	43.9 (43.15, 44.73)***	37.9 (37.17, 38.71)***
Scottish, Australia	21,745 (9.6)	35.1 (34.47, 35.78)*	24.6 (24.06, 25.24)***	40.5 (39.86, 41.21)***	29.2 (28.57, 29.81)***
Scottish, UK	3,759 (1.7)	37.8 (36.28, 39.43)*	27.8 (26.32, 29.23)*	42.9 (41.28, 44.53)	35.8 (34.26, 37.37)***
Welsh, Australia	1,265 (0.6)	36.6 (33.99, 39.38)	25.0 (22.67, 27.51)	40.3 (37.58, 43.11)	30.0 (27.48, 32.58)
Welsh, UK	835 (0.4)	42.4 (39.06, 45.87)***	28.9 (25.89, 32.12)	44.6 (41.14, 48.05)	38.0 (34.68, 41.35)***
Irish, Australia	33,360 (14.7)	35.0 (34.52, 35.58)**	24.1 (23.58, 24.53)***	39.7 (39.20, 40.30)***	30.4 (29.91, 30.94)
Irish, Ireland	1,048 (0.5)	40.9 (37.89, 43.92)***	27.5 (24.90, 30.34)	36.7 (33.71, 39.69)***	36.3 (33.37, 39.25)***
Danish, Australia	695 (0.3)	36.4 (32.84, 40.09)	24.7 (21.58, 28.11)	37.7 (34.11, 41.46)*	30.2 (26.88, 33.74)
Danish, Denmark	178 (0.1)	49.0 (41.63, 56.43)***	34.2 (27.55, 41.57)*	55.3 (47.76, 62.56)***	42.3 (35.15, 49.78)***
French, Australia	1,195 (0.5)	37.9 (35.18, 40.77)	26.3 (23.78, 28.92)	44.1 (41.20, 46.95)	34.1 (31.46, 36.87)**
French, France	237 (0.1)	47.1 (40.76, 53.58)***	29.9 (24.30, 36.10)	53.4 (46.92, 59.85)***	52.0 (45.51, 58.36)***
Swiss, Australia	163 (0.1)	40.9 (33.48, 48.67)	23.5 (17.62, 30.70)	49.7 (41.86, 57.48)	34.5 (27.59, 42.20)
Swiss, Switzerland	224 (0.1)	49.6 (43.01, 56.23)***	35.8 (29.66, 42.36)***	51.1 (44.46, 57.77)***	45.1 (38.62, 51.76)***
German, Australia	9,894 (4.4)	36.1 (35.18, 37.11)	26.4 (25.49, 27.27)	41.4 (40.41, 42.41)	31.0 (30.12, 31.97)
German, Germany	2,073 (0.9)	48.0 (45.82, 50.19)***	35.4 (33.33, 37.54)***	50.6 (48.38, 52.79)***	45.8 (43.63, 47.99)***
Dutch, Australia	1,487 (0.7)	35.0 (32.61, 37.43)	27.8 (25.57, 30.11)	41.6 (39.09, 44.15)	31.2 (28.93, 33.65)
Dutch, Netherlands	2,451 (1.1)	40.8 (38.88, 42.85)***	30.7 (28.87, 32.57)***	42.4 (40.39, 44.43)	37.7 (35.78, 39.68)***
Spanish, Australia	316 (0.1)	40.8 (35.42, 46.36)	28.6 (23.72, 33.93)	46.6 (41.05, 52.22)	30.0 (25.15, 35.25)
Spanish, Spain	158 (0.1)	45.5 (37.82, 53.48)*	31.4 (24.55, 39.12)	53.9 (45.89, 61.72)**	47.3 (39.57, 55.25)***
Italian, Australia	3,259 (1.4)	35.5 (33.88, 37.18)	25.8 (24.33, 27.34)	41.2 (39.49, 42.93)	32.0 (30.42, 33.66)
Italian, Italy	1,922 (0.9)	37.4 (35.21, 39.62)	29.5 (27.48, 31.58)***	48.1 (45.84, 50.43)***	36.5 (34.36, 38.75)***
Greek, Australia	1,072 (0.5)	34.1 (31.36, 37.03)	21.2 (18.92, 23.75)***	44.0 (40.98, 47.03)	30.1 (27.44, 32.96)
Greek, Greece	696 (0.3)	38.6 (35.02, 42.39)	30.5 (27.14, 34.09)**	45.8 (42.01, 49.61)	44.4 (40.63, 48.14)***
Polish, Australia	1,111 (0.5)	39.0 (36.14, 41.91)*	28.7 (26.05, 31.41)	41.8 (38.86, 44.72)	37.8 (34.94, 40.70)***
Polish, Poland	471 (0.2)	47.5 (42.98, 52.12)***	38.7 (34.31, 43.27)***	46.4 (41.80, 51.06)	51.0 (46.37, 55.52)***
Maltese, Australia	675 (0.3)	35.0 (31.53, 38.66)	28.8 (25.49, 32.29)	41.1 (37.47, 44.93)	29.2 (25.94, 32.79)
Maltese, Malta	715 (0.3)	38.7 (35.19, 42.43)	30.1 (26.78, 33.57)*	38.9 (35.29, 42.59)	38.9 (35.31, 42.57)***
Lebanese, Australia	461 (0.2)	34.0 (29.83, 38.49)	23.5 (19.81, 27.54)	37.5 (33.16, 42.06)*	26.2 (22.35, 30.39)*
Lebanese, Lebanon	567 (0.3)	30.9 (27.24, 34.78)*	29.6 (25.99, 33.43)	41.4 (37.34, 45.56)	45.7 (41.56, 49.89)***
Croatian, Australia	218 (0.1)	37.3 (31.12, 43.93)	22.9 (17.83, 28.92)	44.9 (38.34, 51.74)	34.3 (28.32, 40.93)
Croatian, Croatia	349 (0.2)	43.4 (38.20, 48.74)**	40.8 (35.63, 46.14)***	47.3 (42.00, 52.68)	48.0 (42.75, 53.36)***
Indian, Australia	213 (0.1)	39.0 (32.60, 45.72)	20.8 (15.90, 26.69)	43.6 (36.97, 50.42)	32.3 (26.38, 38.90)
Indian, India	668 (0.3)	47.7 (43.91, 51.61)***	26.3 (23.12, 29.66)	26.5 (23.29, 29.88)***	39.4 (35.66, 43.18)***
Chinese, Australia	690 (0.3)	39.3 (35.68, 43.03)	28.7 (25.41, 32.24)	40.5 (36.80, 44.23)	32.8 (29.36, 36.41)
Chinese, China	2,250 (1.0)	53.5 (51.40, 55.62)***	40.5 (38.42, 42.57)***	42.5 (40.42, 44.59)	56.7 (54.62, 58.82)***

*** p < 0.001; ** p < 0.01; * p < 0.05 (from Australian, Australia)

Table 2 reports results from multilevel logit regression. Model 1 reports ethnic and country of birth differences in psychological distress, adjusted for age and gender (sensu Figure 1). We adjusted this model for each social interaction variable individually, and then simultaneously (Model 2). Higher quartiles of each social interaction variable were associated with a lower risk of psychological distress; especially that denoting the number of people that can be relied on (highest quartile odds ratio: 0.36, 95% confidence interval: 0.34, 0.38). Social interactions only fully explained the higher risk of psychological distress experienced by the Chinese born in China (as denoted by statistical

significance). However, there were other instances where odds ratios were attenuated, though remained significant, and this was often for people born outside Australia, such as the Lebanese born in Lebanon (OR=3.97 to 3.67) and the Croatians born in Croatia (OR=2.70 to 2.30). Adjusting for all other individual-level characteristics, neighbourhood affluence and geographical remoteness (Model 3) had a more substantive effect on the ethnic differences (OR=3.67 to 2.11 for the Lebanese born in Lebanon; OR=2.30 to 1.84 for the Croatians born in Croatia).

Table 2: Ethnic and country of birth group differences in the risk of psychological distress, adjusted for social interactions variables and other individual and neighbourhood characteristics

Ethnicity, country of birth	Model 1	Model 2	Model 3
	Odds Ratio (95% Confidence Interval)		
Australian, Australia	1	1	1
Australian, Not Australia	1.83 (1.59, 2.10)***	1.73 (1.50, 1.99)***	1.57 (1.36, 1.82)***
English, Australia	0.93 (0.90, 0.97)***	0.94 (0.90, 0.98)***	0.96 (0.92, 1.00)*
English, UK	0.83 (0.78, 0.88)***	0.75 (0.71, 0.80)***	0.82 (0.77, 0.87)***
Scottish, Australia	0.89 (0.84, 0.93)***	0.90 (0.86, 0.95)***	0.96 (0.91, 1.01)
Scottish, UK	0.81 (0.72, 0.90)***	0.76 (0.68, 0.85)***	0.82 (0.73, 0.92)***
Welsh, Australia	1.10 (0.93, 1.31)	1.12 (0.94, 1.33)	1.19 (1.00, 1.42)
Welsh, UK	0.82 (0.65, 1.04)	0.75 (0.60, 0.95)*	0.84 (0.66, 1.07)
Irish, Australia	0.95 (0.91, 0.99)*	0.96 (0.92, 1.01)	0.99 (0.95, 1.04)
Irish, Ireland	0.93 (0.76, 1.13)	0.87 (0.71, 1.06)	0.92 (0.75, 1.12)
Danish, Australia	0.90 (0.70, 1.15)	0.91 (0.71, 1.17)	0.94 (0.73, 1.21)
Danish, Denmark	0.43 (0.22, 0.84)*	0.36 (0.18, 0.71)**	0.38 (0.19, 0.77)**
French, Australia	1.04 (0.87, 1.24)	1.01 (0.84, 1.21)	0.99 (0.83, 1.19)
French, France	1.08 (0.73, 1.60)	0.87 (0.58, 1.29)	1.00 (0.67, 1.51)
Swiss, Australia	1.01 (0.62, 1.65)	1.00 (0.61, 1.63)	1.14 (0.69, 1.88)
Swiss, Switzerland	0.33 (0.17, 0.65)***	0.27 (0.14, 0.53)***	0.33 (0.17, 0.65)***
German, Australia	1.12 (1.05, 1.19)***	1.11 (1.04, 1.19)***	1.10 (1.02, 1.17)**
German, Germany	0.98 (0.86, 1.13)	0.82 (0.71, 0.94)**	0.87 (0.75, 1.00)*
Dutch, Australia	1.03 (0.88, 1.22)	1.02 (0.87, 1.20)	1.07 (0.90, 1.27)
Dutch, Netherlands	0.96 (0.85, 1.09)	0.88 (0.78, 1.01)	0.91 (0.80, 1.04)
Spanish, Australia	1.08 (0.77, 1.52)	1.08 (0.76, 1.52)	0.92 (0.64, 1.33)
Spanish, Spain	1.35 (0.87, 2.11)	1.14 (0.73, 1.79)	1.06 (0.67, 1.67)
Italian, Australia	1.05 (0.94, 1.18)	1.04 (0.93, 1.17)	1.07 (0.96, 1.21)
Italian, Italy	1.79 (1.59, 2.02)***	1.68 (1.49, 1.89)***	1.46 (1.29, 1.65)**
Greek, Australia	1.07 (0.88, 1.29)	1.08 (0.89, 1.30)	1.11 (0.91, 1.35)
Greek, Greece	2.04 (1.69, 2.46)***	1.81 (1.50, 2.19)***	1.33 (1.10, 1.62)**
Polish, Australia	1.17 (0.98, 1.40)	1.10 (0.92, 1.32)	1.15 (0.95, 1.39)
Polish, Poland	1.89 (1.51, 2.37)***	1.54 (1.22, 1.94)***	1.64 (1.30, 2.08)***
Maltese, Australia	1.26 (1.01, 1.57)*	1.27 (1.01, 1.59)*	1.11 (0.88, 1.41)
Maltese, Malta	1.71 (1.41, 2.09)***	1.59 (1.30, 1.94)***	1.19 (0.97, 1.46)
Lebanese, Australia	1.13 (0.85, 1.50)	1.22 (0.92, 1.62)	1.31 (0.98, 1.75)
Lebanese, Lebanon	3.97 (3.30, 4.76)***	3.67 (3.04, 4.42)***	2.11 (1.73, 2.57)***
Croatian, Australia	0.97 (0.63, 1.49)	0.94 (0.61, 1.46)	1.00 (0.64, 1.56)
Croatian, Croatia	2.70 (2.11, 3.46)***	2.30 (1.78, 2.96)***	1.84 (1.42, 2.39)***
Indian, Australia	1.86 (1.31, 2.63)***	1.88 (1.33, 2.68)***	1.64 (1.14, 2.35)**
Indian, India	1.13 (0.89, 1.43)	1.07 (0.84, 1.36)	1.43 (1.12, 1.83)**
Chinese, Australia	1.18 (0.94, 1.48)	1.16 (0.92, 1.45)	1.18 (0.93, 1.50)
Chinese, China	1.19 (1.05, 1.35)**	0.90 (0.79, 1.02)	1.05 (0.92, 1.20)
Number of occasions spent with friends or family			
Quartile 1 (Low)		1	1
Quartile 2 (Low to Moderate)		0.77 (0.74, 0.81)***	0.78 (0.75, 0.82)***
Quartile 3 (Moderate to High)		0.80 (0.77, 0.83)***	0.78 (0.75, 0.81)***
Quartile 4 (High)		1.00 (0.97, 1.04)	0.89 (0.85, 0.92)***
Number of telephone conversations			
Quartile 1 (Low)		1	1
Quartile 2 (Low to Moderate)		0.77 (0.74, 0.80)***	0.82 (0.79, 0.85)***
Quartile 3 (Moderate to High)		0.79 (0.76, 0.82)***	0.83 (0.80, 0.87)***
Quartile 4 (High)		0.78 (0.75, 0.81)***	0.85 (0.82, 0.88)***

Number of visits to social clubs		
Quartile 1 (Low)	1	1
Quartile 2 (Low to Moderate)	0.75 (0.72, 0.78)***	0.86 (0.83, 0.90)***
Quartile 3 (Moderate to High)	0.77 (0.74, 0.80)***	0.88 (0.84, 0.91)***
Quartile 4 (High)	0.95 (0.92, 0.98)**	1.01 (0.97, 1.04)
Number of people that can be relied on		
Quartile 1 (Low)	1	1
Quartile 2 (Low to Moderate)	0.58 (0.56, 0.61)***	0.66 (0.63, 0.68)***
Quartile 3 (Moderate to High)	0.48 (0.47, 0.50)***	0.56 (0.54, 0.58)***
Quartile 4 (High)	0.36 (0.34, 0.38)***	0.44 (0.42, 0.46)***

* p < 0.05; ** p < 0.01; *** p < 0.001
Model 1: Multilevel logit regression, adjusted for age and gender
Model 2: Model 1 + social interactions
Model 3: Model 2 + other individual-level variables, neighbourhood affluence and geographical remoteness

Figure 2 illustrates the ethnic and country of birth group differences in own-group ethnic density. Regardless of whether participants were born in Australia or the UK, those identifying as Australian (32.6%) or English (35.1%) ethnicities lived in the most ethnically dense neighbourhoods. Compared to the Australians and the English, the clustering of other ethnic groups in NSW was much lower. The highest mean ethnic density for non-Australian and non-English groups was for the Chinese born in China at 14.9%, whereas the lowest was for Australian born Swiss at 0.1%. There was evidence of heterogeneity of mean ethnic density within some groups. For example, Italians born in Australia had a mean of ethnic density of 4.9% but Italian-born Italians had 7.7%. Similar patterns were observed for Greeks, the Chinese and the Lebanese.

<Figure 2 here>

For the next stage of analysis we investigated the level of association with own-group ethnic density. This necessitated stratification of the sample by ethnic and country of birth group to match each individual with the relevant ethnic density measure. For example, Chinese ethnic density was matched to Chinese individuals (irrespective of whether they were born in China or Australia). We conducted these analyses for all groups, but due to space constraints, we focus our report on groups that have a mean ethnic density of 2% or more: Australians, English, Scottish, Irish, German, Italian, Greek, Lebanese, and Chinese. **Table 3 reports mostly weak and positive or null (i.e. p>0.05) correlations between own group ethnic density and each of the social interactions variables. The most consistent set of correlations were for the social interactions variable which indicated how many people could be relied on within a one-hour travel-time.**

Table 3: Correlations between own group ethnic density and each of the social interactions variables, stratified by ethnic and country of birth group

Ethnic group, country of birth	How many times last week did you:			How many people outside your home, within one hour of travel, do you feel you can depend on
	Spend time with friends/family who do not live with you	*Talk to someone (friends, relatives or others)*	*Go to meetings of social clubs, religious groups or other groups you belong to*	
Australia, Australia	0.012**	-0.017***	-0.012**	0.008*
Australian, Not Australia	-0.010	-0.053*	0.005	-0.001
English, Australia	0.019***	0.001	0.013**	-0.001
English, UK	0.0156	-0.010	0.029**	0.006
Scottish, Australia	0.007	0.008	0.001	0.014*
Scottish, UK	0.036*	0.029	-0.007	0.031
Irish, Australia	0.005	0.009	-0.001	0.005
Irish, Ireland	-0.014	-0.012	0.019	-0.027
German, Australia	-0.002	-0.016	0.016	0.024*
German, Germany	-0.022	0.020	-0.004	0.057**
Italian, Australia	0.018	-0.028	-0.035*	0.049**
Italian, Italy	0.028	0.025	0.045	0.086**
Greek, Australia	0.066*	-0.032	-0.028	0.117**
Greek, Greece	0.012	-0.026	0.052	0.017
Lebanese, Australia	-0.033	0.047	0.055	0.273***
Lebanese, Lebanon	-0.029	0.009	-0.061	-0.031
Chinese, Australia	0.048	-0.015	0.008	-0.059
Chinese, China	0.036	0.033	0.082**	-0.007

* p < 0.05; ** p < 0.01; *** p < 0.001

Table 4 reports the results of these ethnic and county of birth group specific models. **Model 1 fitted the association between psychological distress and own-group ethnic density, adjusted for age and gender. A 1% increase in own-group ethnic density appeared protective against psychological distress for the English born in UK, and Australian-born Scottish, Irish and Chinese.** Unexpectedly, increasing ethnic density was associated with a higher risk of psychological distress among Australians born in Australia. This model was adjusted by the social interactions variables (Model 2), but the associations between ethnic density and psychological distress persisted. **Further adjustment for other individual-level variables, local affluence and geographical remoteness (Model 3) had a more substantial attenuating influence on the ethnic density odds ratios and 95% confidence intervals, except that for the English born in the UK and the overseas-born Australians.** We did not find any evidence of interactions between ethnic density and any other independent variables in our models.

Table 4: Association between own-group ethnic density and psychological distress by ethnic group, adjusting for social interactions and other individual and neighbourhood characteristics: Odds Ratios (95% Confidence Intervals)

	Model 1	Model 2	Model 3
		OR (95% CI)	

Australian, Australia	1.01 (1.01, 1.01)***	1.01 (1.01, 1.01)***	1.00 (1.00, 1.00)
Australian, not Australia	0.97 (0.96, 0.99)***	0.98 (0.96, 0.99)**	0.97 (0.95, 0.99)**
English, Australia	1.00 (1.00, 1.00)	1.00 (1.00, 1.00)	1.00 (0.99, 1.00)
English, UK	0.99 (0.99, 1.00)*	0.99 (0.99, 1.00)*	0.99 (0.99, 1.00)*
Scottish, Australia	0.97 (0.94, 1.00)*	0.98 (0.95, 1.01)	0.99 (0.96, 1.01)
Scottish, UK	0.98 (0.91, 1.06)	0.99 (0.92, 1.07)	1.00 (0.93, 1.08)
Irish, Australia	0.98 (0.96, 0.99)**	0.98 (0.97, 1.00)**	1.00 (0.98, 1.01)
Irish, Ireland	0.94 (0.86, 1.03)	0.95 (0.86, 1.04)	0.97 (0.87, 1.07)
German, Australia	0.99 (0.95, 1.03)	0.99 (0.95, 1.04)	1.00 (0.96, 1.04)
German, Germany	1.00 (0.90, 1.11)	1.00 (0.90, 1.12)	1.00 (0.89, 1.12)
Italian, Australia	0.99 (0.97, 1.01)	0.99 (0.98, 1.01)	1.01 (0.99, 1.03)
Italian, Italy	1.00 (0.98, 1.01)	1.00 (0.99, 1.02)	1.00 (0.99, 1.02)
Greek, Australia	0.98 (0.94, 1.02)	0.99 (0.95, 1.04)	1.01 (0.96, 1.05)
Greek, Greece	1.01 (0.99, 1.03)	1.01 (0.99, 1.03)	1.01 (0.98, 1.03)
Lebanese, Australia	1.01 (0.95, 1.07)	1.04 (0.98, 1.10)	0.98 (0.91, 1.06)
Lebanese, Lebanon	1.02 (1.00, 1.05)	1.02 (1.00, 1.05)	1.01 (0.98, 1.04)
Chinese, Australia	0.90 (0.81, 0.99)*	0.86 (0.76, 0.97)*	0.88 (0.70, 1.12)
Chinese, China	1.00 (0.99, 1.01)	1.00 (0.99, 1.01)	1.00 (0.99, 1.01)

*** p < 0.05; ** p < 0.01; * p < 0.05

Model 1: Adjusted for age and gender

Model 2: Model 1 + social interactions

Model 3: Model 2 + individual characteristics, neighbourhood affluence and geographical remoteness

DISCUSSION

This paper examined the relationship between ethnic density and psychological distress in one of the most ethnic diverse areas of Australia. We found substantive heterogeneity in the risk of psychological distress between and within ethnic groups. Ethnic differences in social interactions, individual and neighbourhood characteristics did not explain the ethnic differences in the risk of psychological distress. More social interactions were associated with a lower risk of psychological distress, especially the number of people study participants felt they could rely on. Increasing own-group ethnic density was associated more social interactions and less psychological distress for some ethnic groups, but not all. However, it was the characteristics of individuals and the neighbourhoods in which they lived, not the social interactions, which **mostly** explained the ethnic density effects on psychological distress. Only the English born in the UK and the overseas-born Australians appeared to benefit from ethnic density after controlling for all other characteristics.

Although there are many studies on ethnic density and mental health [4 6 10-18], only two others have tested whether this relationship is explained by social interactions. A UK study [10] found a lower risk of common mental disorders for the Irish and for the Bangladeshi groups they studied in more ethnically dense neighbourhoods. This was not fully explained by measures of practical and emotional social support. Contrary to the ethnic density hypothesis, this study also reported significantly higher risk of common mental disorders among white British in ethnically dense neighbourhoods. A study in the US [11] also showed the benefits of living in a higher own-ethnic group

density neighbourhoods for the emotional well-being of Black and Hispanic groups. Measures of personal and neighbourhood social support partially explained the relationship for Blacks but not among Hispanics. Therefore, despite using contrasting measures of mental health and social interactions for different ethnic groups in the UK, US and Australia, our findings are consistent wherein social interactions only played a weak role in explaining the ethnic density effect on mental health.

A particular strength of our study includes the large sample sizes for many different ethnic groups; more than has been possible to analyse in previous studies [4]. This allowed stratification by country of birth, which afforded new insights into the heterogeneity of mental health, social interactions and ethnic density within groups. **It is noteworthy that levels of ethnic density varied considerably by country of birth within some ethnic groups (e.g. the Chinese), though not all (e.g. the English). Given the general supposition that higher levels of ethnic density are better for mental health, it could be argued that for many groups, levels of ethnic density do not achieve a sufficient concentration necessary for health promotion in this sample. This hypothesis is not convincing, however, when one considers that no association between ethnic density and psychological distress was found for the Chinese born in China, who reported a mean ethnic density of approximately 15% and a maximum of nearly 80%, but there was an association among the Chinese born in Australia, for whom the mean ethnic density was about 5% and a maximum of around 63%. Likewise, there appeared to be a benefit of ethnic density for the UK-born English, but not the English born in Australia, despite having very similar levels of own-group ethnic density. As such, it would appear that a more nuanced approach may be required in future, using other sources of administrative data and qualitative methods to examine what it is about ethnically dense neighbourhoods which promote better mental health in some ethnic groups, but not all.**

Our measures of psychological distress and social interactions have been widely validated. The small geographical scale (CCD) used to construct ethnic density provided a more accurate description of local circumstances than previous work which has relied upon larger spatial scales, helping to identify small 'pockets' of ethnic density and affluence that would otherwise have been hidden [45]. **The focus on small scale geography is an advantage, though our study shares a common limitation among others of this genre in the reliance upon administrative boundaries, which are unlikely to perfectly correlate with residents' perceptions of neighbourhood [46].**

It is reasonable to expect that social support from the neighbourhood would be reflected in the four measures of social interactions used in the study, albeit imperfectly. Social clubs attended, for example, may be located in the neighbourhood and many of the people who can be relied on within one hour of travel may in fact live much closer. The limitation, however, is that the questions used in the 45 and Up Study did not ask participants to distinguish how much of these interactions occurred within versus outside the neighbourhood in which they lived. It would be useful for further work, therefore, to examine indicators which specify neighbourhood parameters within the question. Another limitation was that the 45 and Up Study was sampled from the Medicare Australia database which mainly includes Australian citizens and migrants on permanent residency visas. Only some migrants on temporary visas are included on this scheme and this is likely to mean that some ethnic minorities were not represented in our study. **Representativeness is also a concern for a dataset wherein the response rate was only 18%, although comparisons between**

the 45 and Up Study and a 'representative' dataset have helped to alleviate these concerns to some extent [26]. The 45 and Up Study asked participants about Aboriginal and Torres Strait Islander origin, though responses to this variable were not available for this investigation and are the focus of a follow-up study. Many studies have suggested that spatial variation in the experiences of racism could help to explain the ethnic density effect [14 16]. Although we had no measure of racism in our study, virtually all benefits of ethnic density were already explained by other individual characteristics. Finally, our study represents only people 45 years and older, so it cannot discount the possibility of different patterns for younger age groups.

CONCLUSION

Ethnic groups in New South Wales, Australia, experience substantively different risks of psychological distress. These differences also align by country of birth, though there is no consistent pattern. Increasing social interactions, particularly those which help people to develop relationships with others they can depend on in times of need, are beneficial for mental health regardless of ethnicity and country of birth. In comparison, the ethnic density of where people live was protective only for the UK-born English and the overseas-born Australians.

ACKNOWLEDGEMENTS, COMPETING INTERESTS & FUNDING

We thank all of the men and women who participated in the 45 and Up Study. The 45 and Up Study is managed by the Sax Institute in collaboration with major partner Cancer Council New South Wales; and partners the Heart Foundation (NSW Division); NSW Ministry of Health; *beyondblue: the national depression initiative*; Ageing, Disability and Home Care, NSW Family and Community Services; and the Australian Red Cross Blood Service. We acknowledge the use of 2006 census and boundary data provided by the Australian Bureau of Statistics. To preserve the anonymity of participants in The 45 and Up Study, some parameters of the Census Collector District (CCD) level data cannot be reported. This location-indexing data from the 45 and up Study is highly restricted access and will be made available only through SURE (https://www.sure.org.au/).

The authors have no competing interests.

No funding was sought for this study.

LIST OF FIGURES

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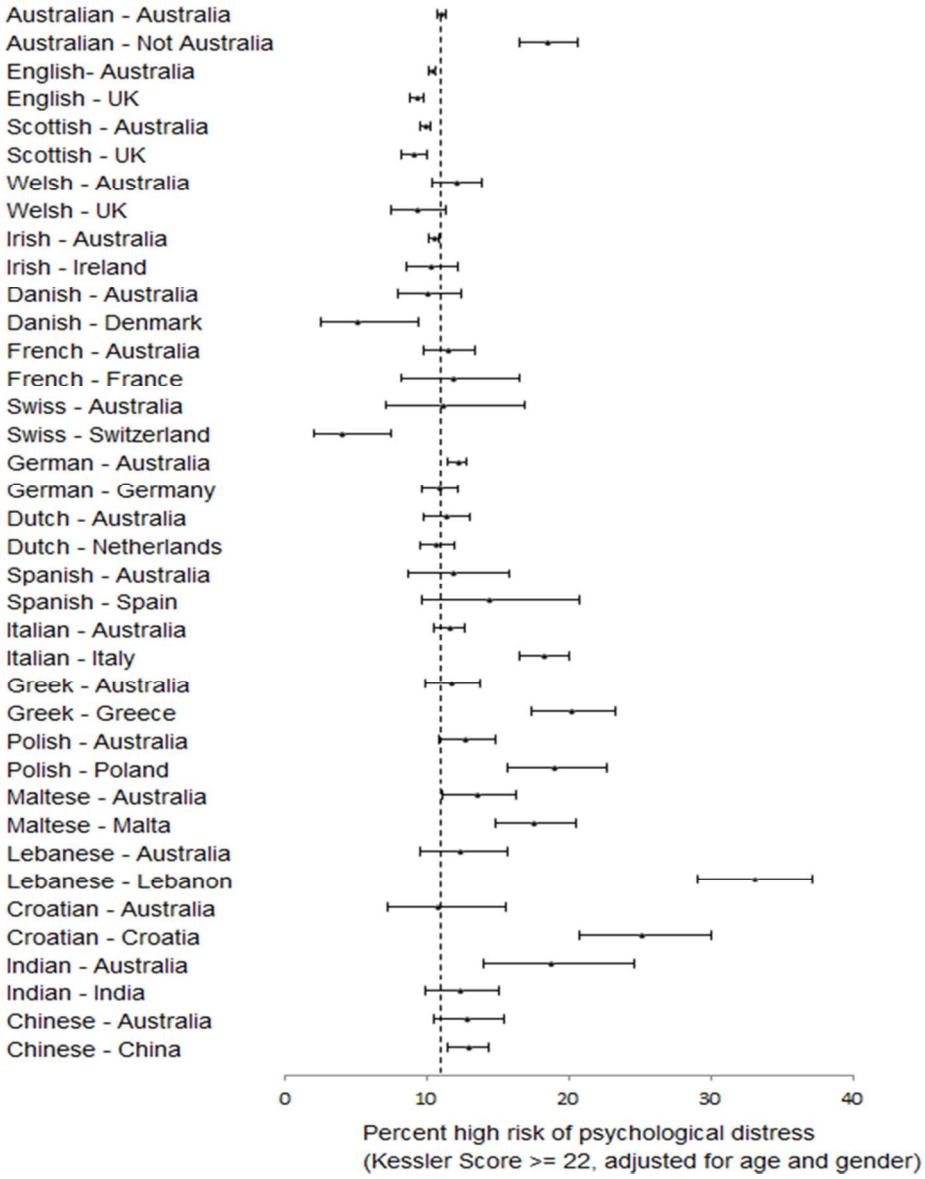
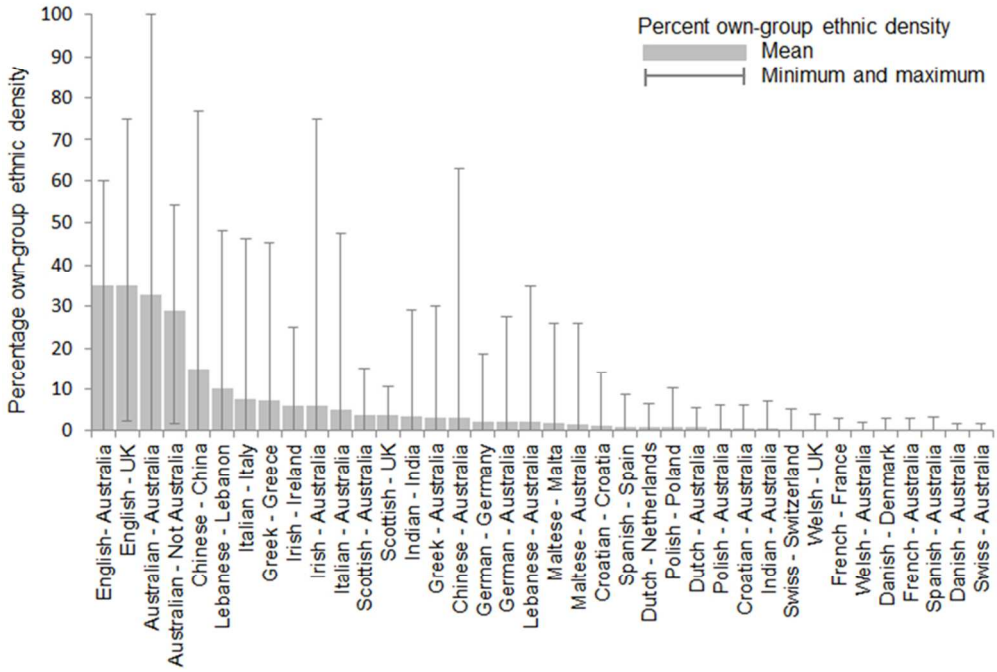


Ethnic and country of birth differences in the rate of psychological distress (Kessler scores of 22 and over), adjusted for age and gender
154x212mm (150 x 129 DPI)



Ethnic and country of birth differences in mean own-group ethnic density (percentage) at the Census Collection District (CCD) scale, with minimum and maximum: sorted highest to lowest
254x179mm (96 x 96 DPI)

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Author comment and page number
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	We have indicated in the title that this is a cross-sectional study. (see page 1)
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	We have provided a structured abstract in line with JECH recommendations. (see page 1)
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	We have explained the scientific background and rationale for the study in a two-paragraph introduction. (see page2)
Objectives	3	State specific objectives, including any prespecified hypotheses	We outline the objective of the study in the second paragraph of the introduction, see page2.
Methods			
Study design	4	Present key elements of study design early in the paper	The study design is outlined in the first paragraph of the methods section, see page 2.
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	The setting is outlined in the second paragraph of the introduction and the first paragraph of the methods section, see page 2.
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	Eligibility criteria and the selection of participant is discussed in paragraph 1 and 2

			of the method section, see page 2 and 3
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	All variables are discussed in paragraphs 2-8 of the method section, see page 2-4
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	The primary source of data is the 45 and Up Study and this outlined in the first paragraph of the method section, see page 2. Details of measurement are provided separately for the outcome variable (psychological distress), other individual variables and neighbourhood level measures, see page 3.
Bias	9	Describe any efforts to address potential sources of bias	Sources of bias were discussed in the paragraph headed 'statistical analysis', see page4. This focuses on adjustment for confounders and for the hierarchical data structure though the use of multilevel models.
Study size	10	Explain how the study size was arrived at	Study size has been explained in paragraph 1 and 2of the method section, see page 2&3
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	All variables have been outlined in the method section, see page 3 & 4 for details.
Statistical methods	12	(*a*) Describe all statistical methods, including those used to	All methods have

		control for confounding	been described in the section headed 'statistical analysis', see page 4. Explanation on how missing data were addressed in paragraph 2 of the method section, see page 3.
		(*b*) Describe any methods used to examine subgroups and interactions	
		(*c*) Explain how missing data were addressed	
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Sample selection was described in paragraph 2 of the method section, see page 2 & 3.
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Characteristics of the study participants including sample sizes and prevalence of key outcome and explanatory variables are reported in paragraph 1-4 of the result section, see page 4 & 5, figure 1&2 and table 1 & 2.
		(b) Indicate number of participants with missing data for each variable of interest	
Outcome data	15*	Report numbers of outcome events or summary measures	
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Sub-group analysis is reported in paragraph 5 & 6 in the result section, see page 5 and table 3.
Discussion			
Key results	18	Summarise key results with reference to study objectives	Key results are outlined briefly in paragraph 1 of the discussion section on page 6.
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and	Strengths and limitations of the

		magnitude of any potential bias	study are discussed in paragraph 3 of the discussion section, see page 6 &7.
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Interpretation of the findings within the context of the previous literature is reported in paragraph 2 of the discussion, see page 6.
Generalisability	21	Discuss the generalisability (external validity) of the study results	
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	No funding was sought for this study.

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

Do social interactions explain ethnic differences in psychological distress and the protective effect of local ethnic density? Evidence from a cross-sectional study of 226,487 adults in middle-to-older age

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KEYWORDS

MENTAL HEALTH; ETHNICITY; MULTILEVEL MODELLING; PUBLIC HEALTH; SOCIAL EPIDEMIOLOGY

WORD COUNT: 2721

Do social interactions explain ethnic differences in psychological distress and the protective effect of local ethnic density? Evidence from a cross-sectional study of 226,487 adults in middle-to-older age

ABSTRACT

Background: A frequently proposed, but under-researched hypothesis is that ethnic density benefits mental health through increasing social interactions. We examined this hypothesis in 226,487 adults from 19 ethnic groups aged 45 years and older in Australia.

Methods: Multilevel logit regression was used to measure association between ethnicity, social interactions, own-group ethnic density and scores of 22+ on the Kessler scale of psychological distress. Self-reported ancestry was used as a proxy for ethnicity. Measures of social interactions included the number of times in the last week were: *i)* spent with friends or family participants did not live with; *ii)* talked to someone on the telephone; *iii)* attended meetings of social groups; and *iv)* how many people could be relied upon outside their home, but within one hour of travel. Per cent own-group ethnic density was measured at the Census Collection District scale.

Results: Psychological distress was reported by 11% of Australians born in Australia. The risk of experiencing psychological distress varied among ethnic minorities and by country of birth (e.g. 33% for the Lebanese born in Lebanon, compared to 4% for the Swiss born in Switzerland). These differences remained after full adjustment. Social interactions varied between ethnic groups and were associated with lower psychological distress and ethnic density. Ethnic density was associated with reduced psychological distress for some groups. This association, however, was explained by individual and neighbourhood characteristics and not by social interactions.

Conclusion: Social interactions are important correlates of mental health, but do not fully explain ethnic differences in psychological distress, nor the protective effect of own-group density.

WHAT IS ALREADY KNOWN ON THIS SUBJECT?

Ethnic differences in mental health, and the reportedly protective influence of own group ethnic density, are largely unexplained in previous studies. Social interactions are widely hypothesised as a mechanism linking ethnic density with more favourable mental health, and may also explain ethnic differences more generally. However, few studies have empirically tested these hypotheses.

WHAT THIS STUDY ADDS?

In a large cohort of Australian adults in middle-to-older age, ethnic differences in mental health were not explained by four measures of social interactions. Protective associations between ethnic density and mental health were largely explained by individual-level socioeconomic characteristics, not social interactions.

Do social interactions explain ethnic differences in psychological distress and the protective effect of local ethnic density? Evidence from a cross-sectional study of 226,487 adults in middle-to-older age

SUMMARY

Article Focus:

- Ethnic differences in mental health, and the reportedly protective influence of own group ethnic density, are largely unexplained in previous studies.
- Social interactions are widely hypothesised as a mechanism linking ethnic density with more favourable mental health, and may also explain ethnic differences more generally. However, few studies have empirically tested these hypotheses.
- We examined this hypothesis in 226,713 adults from 19 ethnic groups aged 45 years and older in Australia.

Key Messages:

- Ethnic differences in mental health persisted after full adjustment; they were not explained by four measures of social interactions, or other individual and neighbourhood characteristics.
- Protective associations between ethnic density and mental health were largely explained by individual-level socioeconomic characteristics, not social interactions.

Strengths and Limitations:

- Large samples allowed for stratification of ethnic groups to investigate differences in mental health, social interactions and ethnic density by country of birth
- The use of a very small geographical scale than in previous work allowed for the ascertainment of local 'pockets' of ethnic density, which would otherwise have been hidden if the study had been dependent upon larger spatial units
- Some of the remaining ethnic inequalities in mental health could be explained by systematic differences in the experience of racial discrimination which we were unable to control for

INTRODUCTION

The existence of ethnic differences in mental health have long been reported, though not fully explained [1-3]. It has been suggested that living in areas of higher own group ethnic density reduces the risk of psychological distress, with increased social support hypothesised to be one of the primary drivers [4]. Social norms and support networks that promote resilience to material disadvantage and sources of psychosocial stress (e.g. racism [5]) are thought to be encouraged and maintained by this geographical clustering of ethnic groups [6]; even in deprived communities [7-9]. However, there is very little empirical evidence on the extent that increased social support explains why some groups tend to report better mental health in ethnically dense neighbourhoods.

Only two studies have been identified that have examined this proposition, one in the UK and another in the US, with equivocal results [10 11]. More broadly, studies of ethnic density and mental health have been mostly based upon adolescents and adults of child-bearing age in European and North American datasets [10-18]. Few studies have been conducted on adults in middle to older age, and no research has been conducted in Australia, which is surprising when one considers that, of the 22.6 million population, over one quarter were born outside Australia [19] and 50% of whom originated from non-English-speaking countries [20].

Australian cities are some of the most ethnically diverse in the world [21] and often contain substantial residential clustering of ethnic groups [22-24]. Contrasting migration histories and residential patterns of ethnic groups means that one cannot assume association between ethnic density and mental health reported in Europe and North America generalises to the Australian context. Therefore, more research is required not only to further understand the mechanisms underlying ethnic density effects, but also to identify the extent that ethnic density may be beneficial to mental health in other ethnically diverse countries like Australia. In this paper we attempt to achieve both of these aims, in addition to an examination of ethnic differences in mental health and the role of social support more generally, through an analysis of a large number of ethnic groups and four measures of social interactions in an Australian cohort of adults.

METHOD

Study population

The 45 and Up study [25] is a large scale cohort of 267,151 residents aged 45 and over in New South Wales ('NSW', the most populous state in Australia). A baseline questionnaire covering a range of health and social issues was distributed to a random sample of adults listed in the Medicare Australia database between 2006 and 2009 inclusive. Medicare Australia is the database through which national healthcare is provided for Australian citizens and permanent residents, as well some temporary residents and refugees [25]. Response to the questionnaire was 18%, which is low, though previous research has suggested that results from the 45 and Up Study are broadly comparable to those derived from 'representative' samples [26]. The University of New South Wales Human Research Ethics Committee approved The 45 and Up Study. Further details including the baseline questionnaire are available to download from www.45andUp.org.au.

Ethnicity status was derived from the first (of up to two) responses to a question on self-reported ancestry ('*What is your ancestry?*'). Secondary responses to this question were not used in the definition of ethnicity as they were not available in our dataset. We focused on the 19 largest groups: Australian, English, Scottish, Welsh, Irish, Danish, French, Swiss, German, Dutch, Spanish, Italian, Greek, Polish, Maltese, Lebanese, Croatian, Indian, and Chinese. Large sample sizes allowed for stratification of each group by country of birth (assessed by the question '*in which country were you born?*') to address healthy-migrant effects. We retained all participants born in Australia (n=179,712), all participants of Australian ethnicity born outside Australia (n=1,336), and participants of non-Australian ethnic groups born in their ethnic-country of origin (n=33,739). Participants of non-Australian ethnic groups born elsewhere (i.e. not Australia or their ethnic-country of origin) were omitted from the sample (n=33,574) for substantive and practical reasons. Non-Australian ethnic groups born overseas and not in the ethnic-country of origin were heterogeneous by definition, which made it difficult to meaningfully interpret any results for to these participants. Furthermore, in practical terms, the sample sizes of many of these groups were small, which also reduced the potential to draw reliable statistical inference. We also omitted all participants missing a postcode identifier (n=263) and those missing a valid outcome measure (n=7,011). Missing data for independent variables was resolved via imputing the mean of the observed values, retaining an overall sample size of n=226,487.

Psychological distress

We used the Kessler Psychological Distress Scale (K10) to evaluate mental health status [27 28]. The K10 measures symptoms of psychological distress experienced over the past four weeks, including feeling tired for no reason, nervous, hopeless, restless, depressed, sad and worthless. Participants had five choices for each of the ten questions (none of the time =1, a little of the time =2, some of the time =3, most of the time =4, all of the time=5) and these were summed to give the overall score. The K10 have been previously used to gauge levels of psychological distress across different countries and ethnic groups [28-31]. We constructed a binary variable wherein a score of 22 or more identified participants with a high risk of psychological distress [32]. The K10 has been used in this binary manner, with 22 as the cut-point, in previous published analyses of The 45 and Up Study [33-35].

Other individual-level measures

Social interactions were measured using four questions from the shortened version of the Duke Social Support Index [36]. Three of the questions tested the number of times in the past week a participant: i) spent time with friends or family they did not live with; ii) talked to someone (friends, relatives or others) on the telephone; iii) attended meetings at social clubs or religious groups. The final question asked participants how many people outside their home, but within one hour travel-time, did they feel close to or could rely on. Previous work has constructed a composite indicator of social support from responses to these questions [37 38], though we analysed each one separately in line with recent studies which have demonstrated that some are more important than others [39].

We also accounted for other individual-level variables (self-reported) which are known to correlate with mental health. These included: age, gender, physical activity, smoking status, Body Mass Index (BMI), highest educational qualifications, economic status, annual household income, couple status, and whether language(s) other than English were spoken at home.

Neighbourhood-level measures

This study used Census Collection Districts (CCD) to define neighbourhoods. With a mean of 225 residents [40], CCDs were the smallest geographical scale for which 2006 Census data was made available [41]. However, 9% of participants in The 45 and Up Study were missing a valid CCD. As nearly 100% had a postcode identifier, we assigned those missing a CCD with a pseudo-CCD according to the location of the population-weighted postcode centroid. Therefore, 100% of the sample could be assigned neighbourhood measures and clustering within regression models could be operationalized at the CCD level.

We constructed the measure of own-group ethnic density from 2006 Census data. The Census question on ancestry (a surrogate for ethnicity in our study) was very similar to that used in the 45 and Up Study ("What is the person's ancestry?"). The number of people within a CCD pertaining to each participant's ethnic group was divided the total usual resident population. For example, Chinese participants (regardless of their country of birth) were assigned the percentage of the population in their CCD who self-identified as Chinese.

Other neighbourhood measures included local affluence and geographical remoteness. We used the Socio-Economic Index for Areas (SEIFA) 'Index of Relative Socio-Economic Advantage/Disadvantage' [42] to measure local affluence. This is a variable derived by the Australian Bureau of Statistics (ABS) using Census variables which relate to advantage and disadvantage, including household income and educational qualifications. This indicator was expressed in percentiles; higher percentiles indicate more affluent areas. Geographical remoteness was measured using the 'Accessibility/Remoteness Index of Australia' (ARIA) [43]. ARIA is a score ranging from 0 to 15, with scores of 2.4 and over used to distinguish between urban and inner regions (<2.4) and rural or remote (>=2.4).

Statistical analysis

The study population was first assessed using descriptive statistics. Measures of ethnic density were mapped across NSW. To investigate ethnic differences in psychological distress, multilevel logistic regression was used to account for the clustering of participants within CCDs [44]. The sample was clustered within 11,621 CCDs (20 participants per CCD on average). CCDs accounted for 3.3% of the variation in psychological distress within a 'null' two-level multilevel model. A categorical variable identifying ethnic groups stratified by country of birth was fitted in this model, which was then adjusted for age and gender. We proceeded to test whether any ethnic differences in psychological distress remained significant after controlling for social interactions, other individual-level variables, local affluence and geographical remoteness. Multilevel logit regression was fitted to ethnic and country of birth-specific groups (i.e. stratified models) to investigate association between psychological distress and own-group ethnic density. To assess whether these associations could be

explained by social interactions, we first tested the extent of correlation between each measure and own-group ethnic density using negative-binomial regression (to account for the skewed distribution of the social interaction variables). Social interactions were then fitted into the logit models, followed by individual-level variables, local affluence and geographical remoteness. Interaction terms were fitted to test for potential synergistic effects between ethnic density and other neighbourhood variables. Statistically significant associations were identified using the log-likelihood ratio test ($p < 0.05$). All analyses were conducted in STATA 12.

RESULTS

Figure 1 reports differences in the age- and gender-adjusted prevalence of psychological distress by ethnicity and country of birth. The rate of high psychological distress was 11% for Australians born in Australia. In comparison, this risk was far higher for some groups, for example, 33% for the Lebanese born in Lebanon, but much lower for others, such as the Swiss born in Switzerland at 4%.There was no consistent effect of migrant status on the risk of psychological distress. For example, the prevalence of psychological distress among Croatians born in Croatia was 14.3% higher than their Australian born Croatian peers. In contrast, no substantive difference in the prevalence of psychological distress was reported among the Chinese, whether born in Australia (12.8%) or China (12.9%), and the Danish born in Australia had twice the risk of their Danish born contemporaries (10% to 5% respectively).

<Figure 1 here>

Table 1 reports the percentage of each ethnic and country of birth group within the lowest quartile of the four social interactions measures. P-values for comparisons between ethnic and country of birth groups for each social interaction variable were calculated using logistic regression. Compared to their Australian-born peers, those born within their ethnic country of origin tended to be more prevalent in the lowest quartile of every measure of social interactions. For the variable denoting how many people a person felt they could rely on, within group differences were notably wide between the Australian-born and those born in the ethnic country of origin for the French (34.1%, 52%), Polish (37.8%, 51%), Lebanese (26.2%, 45.7%) and Chinese (32.8%, 56.7%).

Table 1: Ethnic and country of birth differences in social interactions; percentage in the lowest quartile for each measure of social interactions

Ethnic group, country of birth	N (%)	Social interactions			
		Less likely to spend time with friends/family	*Less likely to talk to someone*	*Less likely to go to social clubs*	*Few people can depend on*
Australia, Australia	61,848 (27.3)	35.9 (35.51, 36.30)	26.1 (25.72, 26.45)	42.1 (41.68, 42.51)	30.5 (30.10, 30.88)
Australian, Not Australia	1,383 (0.6)	37.9 (35.37, 40.54)	30.2 (27.85, 32.73)***	37.9 (35.37, 40.59)***	36.7 (34.15, 39.28)***
English, Australia	50,480 (22.3)	35.6 (35.16, 36.03)	25.5 (25.06, 25.86)*	41.3 (40.89, 41.80)*	30.1 (29.64, 30.49)
English, UK	16,356 (7.2)	41.4 (40.66, 42.21)***	28.5 (27.82, 29.24)***	43.9 (43.15, 44.73)***	37.9 (37.17, 38.71)***
Scottish, Australia	21,745 (9.6)	35.1 (34.47, 35.78)*	24.6 (24.06, 25.24)***	40.5 (39.86, 41.21)***	29.2 (28.57, 29.81)***
Scottish, UK	3,759 (1.7)	37.8 (36.28, 39.43)*	27.8 (26.32, 29.23)*	42.9 (41.28, 44.53)	35.8 (34.26, 37.37)***
Welsh, Australia	1,265 (0.6)	36.6 (33.99, 39.38)	25.0 (22.67, 27.51)	40.3 (37.58, 43.11)	30.0 (27.48, 32.58)
Welsh, UK	835 (0.4)	42.4 (39.06, 45.87)***	28.9 (25.89, 32.12)	44.6 (41.14, 48.05)	38.0 (34.68, 41.35)***
Irish, Australia	33,360 (14.7)	35.0 (34.52, 35.58)**	24.1 (23.58, 24.53)***	39.7 (39.20, 40.30)***	30.4 (29.91, 30.94)
Irish, Ireland	1,048 (0.5)	40.9 (37.89, 43.92)***	27.5 (24.90, 30.34)	36.7 (33.71, 39.69)***	36.3 (33.37, 39.25)***
Danish, Australia	695 (0.3)	36.4 (32.84, 40.09)	24.7 (21.58, 28.11)	37.7 (34.11, 41.46)*	30.2 (26.88, 33.74)
Danish, Denmark	178 (0.1)	49.0 (41.63, 56.43)***	34.2 (27.55, 41.57)*	55.3 (47.76, 62.56)***	42.3 (35.15, 49.78)***
French, Australia	1,195 (0.5)	37.9 (35.18, 40.77)	26.3 (23.78, 28.92)	44.1 (41.20, 46.95)	34.1 (31.46, 36.87)**
French, France	237 (0.1)	47.1 (40.76, 53.58)***	29.9 (24.30, 36.10)	53.4 (46.92, 59.85)***	52.0 (45.51, 58.36)***
Swiss, Australia	163 (0.1)	40.9 (33.48, 48.67)	23.5 (17.62, 30.70)	49.7 (41.86, 57.48)	34.5 (27.59, 42.20)
Swiss, Switzerland	224 (0.1)	49.6 (43.01, 56.23)***	35.8 (29.66, 42.36)***	51.1 (44.46, 57.77)***	45.1 (38.62, 51.76)***
German, Australia	9,894 (4.4)	36.1 (35.18, 37.11)	26.4 (25.49, 27.27)	41.4 (40.41, 42.41)	31.0 (30.12, 31.97)
German, Germany	2,073 (0.9)	48.0 (45.82, 50.19)***	35.4 (33.33, 37.54)***	50.6 (48.38, 52.79)***	45.8 (43.63, 47.99)***
Dutch, Australia	1,487 (0.7)	35.0 (32.61, 37.43)	27.8 (25.57, 30.11)	41.6 (39.09, 44.15)	31.2 (28.93, 33.65)
Dutch, Netherlands	2,451 (1.1)	40.8 (38.88, 42.85)***	30.7 (28.87, 32.57)***	42.4 (40.39, 44.43)	37.7 (35.78, 39.68)***
Spanish, Australia	316 (0.1)	40.8 (35.42, 46.36)	28.6 (23.72, 33.93)	46.6 (41.05, 52.22)	30.0 (25.15, 35.25)
Spanish, Spain	158 (0.1)	45.5 (37.82, 53.48)*	31.4 (24.55, 39.12)	53.9 (45.89, 61.72)**	47.3 (39.57, 55.25)***
Italian, Australia	3,259 (1.4)	35.5 (33.88, 37.18)	25.8 (24.33, 27.34)	41.2 (39.49, 42.93)	32.0 (30.42, 33.66)
Italian, Italy	1,922 (0.9)	37.4 (35.21, 39.62)	29.5 (27.48, 31.58)***	48.1 (45.84, 50.43)***	36.5 (34.36, 38.75)***
Greek, Australia	1,072 (0.5)	34.1 (31.36, 37.03)	21.2 (18.92, 23.75)***	44.0 (40.98, 47.03)	30.1 (27.44, 32.96)
Greek, Greece	696 (0.3)	38.6 (35.02, 42.39)	30.5 (27.14, 34.09)**	45.8 (42.01, 49.61)	44.4 (40.63, 48.14)***
Polish, Australia	1,111 (0.5)	39.0 (36.14, 41.91)*	28.7 (26.05, 31.41)	41.8 (38.86, 44.72)	37.8 (34.94, 40.70)***
Polish, Poland	471 (0.2)	47.5 (42.98, 52.12)***	38.7 (34.31, 43.27)***	46.4 (41.80, 51.06)	51.0 (46.37, 55.52)***
Maltese, Australia	675 (0.3)	35.0 (31.53, 38.66)	28.8 (25.49, 32.29)	41.1 (37.47, 44.93)	29.2 (25.94, 32.79)
Maltese, Malta	715 (0.3)	38.7 (35.19, 42.43)	30.1 (26.78, 33.57)*	38.9 (35.29, 42.59)	38.9 (35.31, 42.57)***
Lebanese, Australia	461 (0.2)	34.0 (29.83, 38.49)	23.5 (19.81, 27.54)	37.5 (33.16, 42.06)*	26.2 (22.35, 30.39)*
Lebanese, Lebanon	567 (0.3)	30.9 (27.24, 34.78)*	29.6 (25.99, 33.43)	41.4 (37.34, 45.56)	45.7 (41.56, 49.89)***
Croatian, Australia	218 (0.1)	37.3 (31.12, 43.93)	22.9 (17.83, 28.92)	44.9 (38.34, 51.74)	34.3 (28.32, 40.93)
Croatian, Croatia	349 (0.2)	43.4 (38.20, 48.74)**	40.8 (35.63, 46.14)***	47.3 (42.00, 52.68)	48.0 (42.75, 53.36)***
Indian, Australia	213 (0.1)	39.0 (32.60, 45.72)	20.8 (15.90, 26.69)	43.6 (36.97, 50.42)	32.3 (26.38, 38.90)
Indian, India	668 (0.3)	47.7 (43.91, 51.61)***	26.3 (23.12, 29.66)	26.5 (23.29, 29.88)***	39.4 (35.66, 43.18)***
Chinese, Australia	690 (0.3)	39.3 (35.68, 43.03)	28.7 (25.41, 32.24)	40.5 (36.80, 44.23)	32.8 (29.36, 36.41)
Chinese, China	2,250 (1.0)	53.5 (51.40, 55.62)***	40.5 (38.42, 42.57)***	42.5 (40.42, 44.59)	56.7 (54.62, 58.82)***

*** p < 0.001; ** p < 0.01; * p < 0.05 (from Australian, Australia)

Table 2 reports results from multilevel logit regression. Model 1 reports ethnic and country of birth differences in psychological distress, adjusted for age and gender (sensu Figure 1). We adjusted this model for each social interaction variable individually, and then simultaneously (Model 2). Higher quartiles of each social interaction variable were associated with a lower risk of psychological distress; especially that denoting the number of people that can be relied on (highest quartile odds ratio: 0.36, 95% confidence interval: 0.34, 0.38). Social interactions only fully explained the higher risk of psychological distress experienced by the Chinese born in China (as denoted by statistical

significance). However, there were other instances where odds ratios were attenuated, though remained significant, and this was often for people born outside Australia, such as the Lebanese born in Lebanon (OR=3.97 to 3.67) and the Croatians born in Croatia (OR=2.70 to 2.30). Adjusting for all other individual-level characteristics, neighbourhood affluence and geographical remoteness (Model 3) had a more substantive effect on the ethnic differences (OR=3.67 to 2.11 for the Lebanese born in Lebanon; OR=2.30 to 1.84 for the Croatians born in Croatia).

Table 2: Ethnic and country of birth group differences in the risk of psychological distress, adjusted for social interactions variables and other individual and neighbourhood characteristics

Ethnicity, country of birth	Model 1	Model 2	Model 3
	Odds Ratio (95% Confidence Interval)		
Australian, Australia	1	1	1
Australian, Not Australia	1.83 (1.59, 2.10)***	1.73 (1.50, 1.99)***	1.57 (1.36, 1.82)***
English, Australia	0.93 (0.90, 0.97)***	0.94 (0.90, 0.98)***	0.96 (0.92, 1.00)*
English, UK	0.83 (0.78, 0.88)***	0.75 (0.71, 0.80)***	0.82 (0.77, 0.87)***
Scottish, Australia	0.89 (0.84, 0.93)***	0.90 (0.86, 0.95)***	0.96 (0.91, 1.01)
Scottish, UK	0.81 (0.72, 0.90)***	0.76 (0.68, 0.85)***	0.82 (0.73, 0.92)***
Welsh, Australia	1.10 (0.93, 1.31)	1.12 (0.94, 1.33)	1.19 (1.00, 1.42)
Welsh, UK	0.82 (0.65, 1.04)	0.75 (0.60, 0.95)*	0.84 (0.66, 1.07)
Irish, Australia	0.95 (0.91, 0.99)*	0.96 (0.92, 1.01)	0.99 (0.95, 1.04)
Irish, Ireland	0.93 (0.76, 1.13)	0.87 (0.71, 1.06)	0.92 (0.75, 1.12)
Danish, Australia	0.90 (0.70, 1.15)	0.91 (0.71, 1.17)	0.94 (0.73, 1.21)
Danish, Denmark	0.43 (0.22, 0.84)*	0.36 (0.18, 0.71)**	0.38 (0.19, 0.77)**
French, Australia	1.04 (0.87, 1.24)	1.01 (0.84, 1.21)	0.99 (0.83, 1.19)
French, France	1.08 (0.73, 1.60)	0.87 (0.58, 1.29)	1.00 (0.67, 1.51)
Swiss, Australia	1.01 (0.62, 1.65)	1.00 (0.61, 1.63)	1.14 (0.69, 1.88)
Swiss, Switzerland	0.33 (0.17, 0.65)***	0.27 (0.14, 0.53)***	0.33 (0.17, 0.65)***
German, Australia	1.12 (1.05, 1.19)***	1.11 (1.04, 1.19)***	1.10 (1.02, 1.17)**
German, Germany	0.98 (0.86, 1.13)	0.82 (0.71, 0.94)**	0.87 (0.75, 1.00)*
Dutch, Australia	1.03 (0.88, 1.22)	1.02 (0.87, 1.20)	1.07 (0.90, 1.27)
Dutch, Netherlands	0.96 (0.85, 1.09)	0.88 (0.78, 1.01)	0.91 (0.80, 1.04)
Spanish, Australia	1.08 (0.77, 1.52)	1.08 (0.76, 1.52)	0.92 (0.64, 1.33)
Spanish, Spain	1.35 (0.87, 2.11)	1.14 (0.73, 1.79)	1.06 (0.67, 1.67)
Italian, Australia	1.05 (0.94, 1.18)	1.04 (0.93, 1.17)	1.07 (0.96, 1.21)
Italian, Italy	1.79 (1.59, 2.02)***	1.68 (1.49, 1.89)***	1.46 (1.29, 1.65)**
Greek, Australia	1.07 (0.88, 1.29)	1.08 (0.89, 1.30)	1.11 (0.91, 1.35)
Greek, Greece	2.04 (1.69, 2.46)***	1.81 (1.50, 2.19)***	1.33 (1.10, 1.62)**
Polish, Australia	1.17 (0.98, 1.40)	1.10 (0.92, 1.32)	1.15 (0.95, 1.39)
Polish, Poland	1.89 (1.51, 2.37)***	1.54 (1.22, 1.94)***	1.64 (1.30, 2.08)***
Maltese, Australia	1.26 (1.01, 1.57)*	1.27 (1.01, 1.59)*	1.11 (0.88, 1.41)
Maltese, Malta	1.71 (1.41, 2.09)***	1.59 (1.30, 1.94)***	1.19 (0.97, 1.46)
Lebanese, Australia	1.13 (0.85, 1.50)	1.22 (0.92, 1.62)	1.31 (0.98, 1.75)
Lebanese, Lebanon	3.97 (3.30, 4.76)***	3.67 (3.04, 4.42)***	2.11 (1.73, 2.57)***
Croatian, Australia	0.97 (0.63, 1.49)	0.94 (0.61, 1.46)	1.00 (0.64, 1.56)
Croatian, Croatia	2.70 (2.11, 3.46)***	2.30 (1.78, 2.96)***	1.84 (1.42, 2.39)***
Indian, Australia	1.86 (1.31, 2.63)***	1.88 (1.33, 2.68)***	1.64 (1.14, 2.35)**
Indian, India	1.13 (0.89, 1.43)	1.07 (0.84, 1.36)	1.43 (1.12, 1.83)**
Chinese, Australia	1.18 (0.94, 1.48)	1.16 (0.92, 1.45)	1.18 (0.93, 1.50)
Chinese, China	1.19 (1.05, 1.35)**	0.90 (0.79, 1.02)	1.05 (0.92, 1.20)
Number of occasions spent with friends or family			
Quartile 1 (Low)		1	1
Quartile 2 (Low to Moderate)		0.77 (0.74, 0.81)***	0.78 (0.75, 0.82)***
Quartile 3 (Moderate to High)		0.80 (0.77, 0.83)***	0.78 (0.75, 0.81)***
Quartile 4 (High)		1.00 (0.97, 1.04)	0.89 (0.85, 0.92)***
Number of telephone conversations			
Quartile 1 (Low)		1	1
Quartile 2 (Low to Moderate)		0.77 (0.74, 0.80)***	0.82 (0.79, 0.85)***
Quartile 3 (Moderate to High)		0.79 (0.76, 0.82)***	0.83 (0.80, 0.87)***
Quartile 4 (High)		0.78 (0.75, 0.81)***	0.85 (0.82, 0.88)***

Number of visits to social clubs		
Quartile 1 (Low)	1	1
Quartile 2 (Low to Moderate)	0.75 (0.72, 0.78)***	0.86 (0.83, 0.90)***
Quartile 3 (Moderate to High)	0.77 (0.74, 0.80)***	0.88 (0.84, 0.91)***
Quartile 4 (High)	0.95 (0.92, 0.98)**	1.01 (0.97, 1.04)
Number of people that can be relied on		
Quartile 1 (Low)	1	1
Quartile 2 (Low to Moderate)	0.58 (0.56, 0.61)***	0.66 (0.63, 0.68)***
Quartile 3 (Moderate to High)	0.48 (0.47, 0.50)***	0.56 (0.54, 0.58)***
Quartile 4 (High)	0.36 (0.34, 0.38)***	0.44 (0.42, 0.46)***

* p < 0.05; ** p < 0.01; *** p < 0.001
Model 1: Multilevel logit regression, adjusted for age and gender
Model 2: Model 1 + social interactions
Model 3: Model 2 + other individual-level variables, neighbourhood affluence and geographical remoteness

Figure 2 illustrates the ethnic and country of birth group differences in own-group ethnic density. Regardless of whether participants were born in Australia or the UK, those identifying as Australian (32.6%) or English (35.1%) ethnicities lived in the most ethnically dense neighbourhoods. Compared to the Australians and the English, the clustering of other ethnic groups in NSW was much lower. The highest mean ethnic density for non-Australian and non-English groups was for the Chinese born in China at 14.9%, whereas the lowest was for Australian born Swiss at 0.1%. There was evidence of heterogeneity of mean ethnic density within some groups. For example, Italians born in Australia had a mean of ethnic density of 4.9% but Italian-born Italians had 7.7%. Similar patterns were observed for Greeks, the Chinese and the Lebanese.

<Figure 2 here>

For the next stage of analysis we investigated the level of association with own-group ethnic density. This necessitated stratification of the sample by ethnic and country of birth group to match each individual with the relevant ethnic density measure. For example, Chinese ethnic density was matched to Chinese individuals (irrespective of whether they were born in China or Australia). We conducted these analyses for all groups, but due to space constraints, we focus our report on groups that have a mean ethnic density of 2% or more: Australians, English, Scottish, Irish, German, Italian, Greek, Lebanese, and Chinese. Table 3 reports mostly weak and positive or null (i.e. p>0.05) correlations between own group ethnic density and each of the social interactions variables. The most consistent set of correlations were for the social interactions variable which indicated how many people could be relied on within a one-hour travel-time.

Table 3: Correlations between own group ethnic density and each of the social interactions variables, stratified by ethnic and country of birth group

Ethnic group, country of birth	How many times last week did you:			How many people outside your home, within one hour of travel, do you feel you can depend on
	Spend time with friends/family who do not live with you	*Talk to someone (friends, relatives or others)*	*Go to meetings of social clubs, religious groups or other groups you belong to*	
Australia, Australia	0.012**	-0.017***	-0.012**	0.008*
Australian, Not Australia	-0.010	-0.053*	0.005	-0.001
English, Australia	0.019***	0.001	0.013**	-0.001
English, UK	0.0156	-0.010	0.029**	0.006
Scottish, Australia	0.007	0.008	0.001	0.014*
Scottish, UK	0.036*	0.029	-0.007	0.031
Irish, Australia	0.005	0.009	-0.001	0.005
Irish, Ireland	-0.014	-0.012	0.019	-0.027
German, Australia	-0.002	-0.016	0.016	0.024*
German, Germany	-0.022	0.020	-0.004	0.057**
Italian, Australia	0.018	-0.028	-0.035*	0.049**
Italian, Italy	0.028	0.025	0.045	0.086**
Greek, Australia	0.066*	-0.032	-0.028	0.117**
Greek, Greece	0.012	-0.026	0.052	0.017
Lebanese, Australia	-0.033	0.047	0.055	0.273***
Lebanese, Lebanon	-0.029	0.009	-0.061	-0.031
Chinese, Australia	0.048	-0.015	0.008	-0.059
Chinese, China	0.036	0.033	0.082**	-0.007

* p < 0.05; ** p < 0.01; *** p < 0.001

Table 4 reports the results of these ethnic and county of birth group specific models. Model 1 fitted the association between psychological distress and own-group ethnic density, adjusted for age and gender. A 1% increase in own-group ethnic density appeared protective against psychological distress for the English born in UK, and Australian-born Scottish, Irish and Chinese. Unexpectedly, increasing ethnic density was associated with a higher risk of psychological distress among Australians born in Australia. This model was adjusted by the social interactions variables (Model 2), but the associations between ethnic density and psychological distress persisted. Further adjustment for other individual-level variables, local affluence and geographical remoteness (Model 3) had a more substantial attenuating influence on the ethnic density odds ratios and 95% confidence intervals, except that for the English born in the UK and the overseas-born Australians. We did not find any evidence of interactions between ethnic density and any other independent variables in our models.

Table 4: Association between own-group ethnic density and psychological distress by ethnic group, adjusting for social interactions and other individual and neighbourhood characteristics: Odds Ratios (95% Confidence Intervals)

	Model 1	Model 2	Model 3
	OR (95% CI)		

Australian, Australia	1.01 (1.01, 1.01)***	1.01 (1.01, 1.01)***	1.00 (1.00, 1.00)
Australian, not Australia	0.97 (0.96, 0.99)***	0.98 (0.96, 0.99)**	0.97 (0.95, 0.99)**
English, Australia	1.00 (1.00, 1.00)	1.00 (1.00, 1.00)	1.00 (0.99, 1.00)
English, UK	0.99 (0.99, 1.00)*	0.99 (0.99, 1.00)*	0.99 (0.99, 1.00)*
Scottish, Australia	0.97 (0.94, 1.00)*	0.98 (0.95, 1.01)	0.99 (0.96, 1.01)
Scottish, UK	0.98 (0.91, 1.06)	0.99 (0.92, 1.07)	1.00 (0.93, 1.08)
Irish, Australia	0.98 (0.96, 0.99)**	0.98 (0.97, 1.00)**	1.00 (0.98, 1.01)
Irish, Ireland	0.94 (0.86, 1.03)	0.95 (0.86, 1.04)	0.97 (0.87, 1.07)
German, Australia	0.99 (0.95, 1.03)	0.99 (0.95, 1.04)	1.00 (0.96, 1.04)
German, Germany	1.00 (0.90, 1.11)	1.00 (0.90, 1.12)	1.00 (0.89, 1.12)
Italian, Australia	0.99 (0.97, 1.01)	0.99 (0.98, 1.01)	1.01 (0.99, 1.03)
Italian, Italy	1.00 (0.98, 1.01)	1.00 (0.99, 1.02)	1.00 (0.99, 1.02)
Greek, Australia	0.98 (0.94, 1.02)	0.99 (0.95, 1.04)	1.01 (0.96, 1.05)
Greek, Greece	1.01 (0.99, 1.03)	1.01 (0.99, 1.03)	1.01 (0.98, 1.03)
Lebanese, Australia	1.01 (0.95, 1.07)	1.04 (0.98, 1.10)	0.98 (0.91, 1.06)
Lebanese, Lebanon	1.02 (1.00, 1.05)	1.02 (1.00, 1.05)	1.01 (0.98, 1.04)
Chinese, Australia	0.90 (0.81, 0.99)*	0.86 (0.76, 0.97)*	0.88 (0.70, 1.12)
Chinese, China	1.00 (0.99, 1.01)	1.00 (0.99, 1.01)	1.00 (0.99, 1.01)

*** p < 0.05; ** p < 0.01; * p < 0.05

Model 1: Adjusted for age and gender

Model 2: Model 1 + social interactions

Model 3: Model 2 + individual characteristics, neighbourhood affluence and geographical remoteness

DISCUSSION

This paper examined the relationship between ethnic density and psychological distress in one of the most ethnic diverse areas of Australia. We found substantive heterogeneity in the risk of psychological distress between and within ethnic groups. Ethnic differences in social interactions, individual and neighbourhood characteristics did not explain the ethnic differences in the risk of psychological distress. More social interactions were associated with a lower risk of psychological distress, especially the number of people study participants felt they could rely on. Increasing own-group ethnic density was associated more social interactions and less psychological distress for some ethnic groups, but not all. However, it was the characteristics of individuals and the neighbourhoods in which they lived, not the social interactions, which mostly explained the ethnic density effects on psychological distress. Only the English born in the UK and the overseas-born Australians appeared to benefit from ethnic density after controlling for all other characteristics.

Although there are many studies on ethnic density and mental health [4 6 10-18], only two others have tested whether this relationship is explained by social interactions. A UK study [10] found a lower risk of common mental disorders for the Irish and for the Bangladeshi groups they studied in more ethnically dense neighbourhoods. This was not fully explained by measures of practical and emotional social support. Contrary to the ethnic density hypothesis, this study also reported significantly higher risk of common mental disorders among white British in ethnically dense neighbourhoods. A study in the US [11] also showed the benefits of living in a higher own-ethnic group

density neighbourhoods for the emotional well-being of Black and Hispanic groups. Measures of personal and neighbourhood social support partially explained the relationship for Blacks but not among Hispanics. Therefore, despite using contrasting measures of mental health and social interactions for different ethnic groups in the UK, US and Australia, our findings are consistent wherein social interactions only played a weak role in explaining the ethnic density effect on mental health.

A particular strength of our study includes the large sample sizes for many different ethnic groups; more than has been possible to analyse in previous studies [4]. This allowed stratification by country of birth, which afforded new insights into the heterogeneity of mental health, social interactions and ethnic density within groups. It is noteworthy that levels of ethnic density varied considerably by country of birth within some ethnic groups (e.g. the Chinese), though not all (e.g. the English). Given the general supposition that higher levels of ethnic density are better for mental health, it could be argued that for many groups, levels of ethnic density do not achieve a sufficient concentration necessary for health promotion in this sample. This hypothesis is not convincing, however, when one considers that no association between ethnic density and psychological distress was found for the Chinese born in China, who reported a mean ethnic density of approximately 15% and a maximum of nearly 80%, but there was an association among the Chinese born in Australia, for whom the mean ethnic density was about 5% and a maximum of around 63%. Likewise, there appeared to be a benefit of ethnic density for the UK-born English, but not the English born in Australia, despite having very similar levels of own-group ethnic density. As such, it would appear that a more nuanced approach may be required in future, using other sources of administrative data and qualitative methods to examine what it is about ethnically dense neighbourhoods which promote better mental health in some ethnic groups, but not all.

Our measures of psychological distress and social interactions have been widely validated. The small geographical scale (CCD) used to construct ethnic density provided a more accurate description of local circumstances than previous work which has relied upon larger spatial scales, helping to identify small 'pockets' of ethnic density and affluence that would otherwise have been hidden [45]. The focus on small scale geography is an advantage, though our study shares a common limitation among others of this genre in the reliance upon administrative boundaries, which are unlikely to perfectly correlate with residents' perceptions of neighbourhood [46].

It is reasonable to expect that social support from the neighbourhood would be reflected in the four measures of social interactions used in the study, albeit imperfectly. Social clubs attended, for example, may be located in the neighbourhood and many of the people who can be relied on within one hour of travel may in fact live much closer. The limitation, however, is that the questions used in the 45 and Up Study did not ask participants to distinguish how much of these interactions occurred within versus outside the neighbourhood in which they lived. It would be useful for further work, therefore, to examine indicators which specify neighbourhood parameters within the question. Another limitation was that the 45 and Up Study was sampled from the Medicare Australia database which mainly includes Australian citizens and migrants on permanent residency visas. Only some migrants on temporary visas are included on this scheme and this is likely to mean that some ethnic minorities were not represented in our study. Representativeness is also a concern for a dataset wherein the response rate was only 18%, although comparisons between the 45 and Up Study and a 'representative' dataset have helped to alleviate these concerns to some extent [26]. The 45 and Up

Study asked participants about Aboriginal and Torres Strait Islander origin, though responses to this variable were not available for this investigation and are the focus of a follow-up study. Many studies have suggested that spatial variation in the experiences of racism could help to explain the ethnic density effect [14 16]. Although we had no measure of racism in our study, virtually all benefits of ethnic density were already explained by other individual characteristics. Finally, our study represents only people 45 years and older, so it cannot discount the possibility of different patterns for younger age groups.

CONCLUSION

Ethnic groups in New South Wales, Australia, experience substantively different risks of psychological distress. These differences also align by country of birth, though there is no consistent pattern. Increasing social interactions, particularly those which help people to develop relationships with others they can depend on in times of need, are beneficial for mental health regardless of ethnicity and country of birth. In comparison, the ethnic density of where people live was protective only for the UK-born English and the overseas-born Australians.

ACKNOWLEDGEMENTS, COMPETING INTERESTS & FUNDING

We thank all of the men and women who participated in the 45 and Up Study. The 45 and Up Study is managed by the Sax Institute in collaboration with major partner Cancer Council New South Wales; and partners the Heart Foundation (NSW Division); NSW Ministry of Health; *beyondblue: the national depression initiative*; Ageing, Disability and Home Care, NSW Family and Community Services; and the Australian Red Cross Blood Service. We acknowledge the use of 2006 census and boundary data provided by the Australian Bureau of Statistics. To preserve the anonymity of participants in The 45 and Up Study, some parameters of the Census Collector District (CCD) level data cannot be reported. This location-indexing data from the 45 and up Study is highly restricted access and will be made available only through SURE (https://www.sure.org.au/).

The authors have no competing interests.

No funding was sought for this study.

LIST OF FIGURES

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Do social interactions explain ethnic differences in psychological distress and the protective effect of local ethnic density? Evidence from a cross-sectional study of 226,487 adults in middle-to-older age

Journal:	*BMJ Open*
Manuscript ID:	bmjopen-2013-002713.R2
Article Type:	Research
Date Submitted by the Author:	07-Apr-2013
Complete List of Authors:	Feng, Xiaoqi; University of Western Sydney, Centre for Health Research,School of Medicine Astell-Burt, Thomas; University of Western Sydney, School of Science and Health Kolt, Gregory; University of Western Sydney, School of Science and Health
Primary Subject Heading:	Epidemiology
Secondary Subject Heading:	Mental health, Public health, Sociology
Keywords:	MENTAL HEALTH, EPIDEMIOLOGY, PUBLIC HEALTH, SOCIAL MEDICINE

Do social interactions explain ethnic differences in psychological distress and the protective effect of local ethnic density? Evidence from a cross-sectional study of 226,487 adults in middle-to-older age

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KEYWORDS

MENTAL HEALTH; ETHNICITY; MULTILEVEL MODELLING; PUBLIC HEALTH; SOCIAL EPIDEMIOLOGY

WORD COUNT: 3603

Do social interactions explain ethnic differences in psychological distress and the protective effect of local ethnic density? Evidence from a cross-sectional study of 226,487 adults in middle-to-older age

ABSTRACT

Background: A frequently proposed, but under-researched hypothesis is that ethnic density benefits mental health through increasing social interactions. We examined this hypothesis in 226,487 adults from 19 ethnic groups aged 45 years and older in Australia.

Methods: Multilevel logit regression was used to measure association between ethnicity, social interactions, own-group ethnic density and scores of 22+ on the Kessler scale of psychological distress. Self-reported ancestry was used as a proxy for ethnicity. Measures of social interactions included the number of times in the last week were: *i)* spent with friends or family participants did not live with; *ii)* talked to someone on the telephone; *iii)* attended meetings of social groups; and *iv)* how many people could be relied upon outside their home, but within one hour of travel. Per cent own-group ethnic density was measured at the Census Collection District scale.

Results: Psychological distress was reported by 11% of Australians born in Australia. The risk of experiencing psychological distress varied among ethnic minorities and by country of birth (e.g. 33% for the Lebanese born in Lebanon, compared to 4% for the Swiss born in Switzerland). These differences remained after full adjustment. Social interactions varied between ethnic groups and were associated with lower psychological distress and ethnic density. Ethnic density was associated with reduced psychological distress for some groups. This association, however, was explained by individual and neighbourhood characteristics and not by social interactions.

Conclusion: Social interactions are important correlates of mental health, but do not fully explain ethnic differences in psychological distress, nor the protective effect of own-group density.

WHAT IS ALREADY KNOWN ON THIS SUBJECT?

Ethnic differences in mental health, and the reportedly protective influence of own group ethnic density, are largely unexplained in previous studies. Social interactions are widely hypothesised as a mechanism linking ethnic density with more favourable mental health, and may also explain ethnic differences more generally. However, few studies have empirically tested these hypotheses.

WHAT THIS STUDY ADDS?

In a large cohort of Australian adults in middle-to-older age, ethnic differences in mental health were not explained by four measures of social interactions. Protective associations between ethnic density and mental health were largely explained by individual-level socioeconomic characteristics, not social interactions.

Do social interactions explain ethnic differences in psychological distress and the protective effect of local ethnic density? Evidence from a cross-sectional study of 226,487 adults in middle-to-older age

SUMMARY

Article Focus:

- Ethnic differences in mental health, and the reportedly protective influence of own group ethnic density, are largely unexplained in previous studies.
- Social interactions are widely hypothesised as a mechanism linking ethnic density with more favourable mental health, and may also explain ethnic differences more generally. However, few studies have empirically tested these hypotheses.
- We examined this hypothesis in 226,713 adults from 19 ethnic groups aged 45 years and older in Australia.

Key Messages:

- Ethnic differences in mental health persisted after full adjustment; they were not explained by four measures of social interactions, or other individual and neighbourhood characteristics.
- Protective associations between ethnic density and mental health were largely explained by individual-level socioeconomic characteristics, not social interactions.

Strengths and Limitations:

- Large samples allowed for stratification of ethnic groups to investigate differences in mental health, social interactions and ethnic density by country of birth
- The use of a very small geographical scale than in previous work allowed for the ascertainment of local 'pockets' of ethnic density, which would otherwise have been hidden if the study had been dependent upon larger spatial units
- Some of the remaining ethnic inequalities in mental health could be explained by systematic differences in the experience of racial discrimination which we were unable to control for

INTRODUCTION

The existence of ethnic differences in mental health have long been reported, though not fully explained [1-3]. It has been suggested that living in areas of higher own group ethnic density reduces the risk of psychological distress, with increased social support hypothesised to be one of the primary drivers [4]. Social norms and support networks that promote resilience to material disadvantage and sources of psychosocial stress (e.g. racism [5]) are thought to be encouraged and maintained by this geographical clustering of ethnic groups [6]; even in deprived communities [7-9]. However, there is very little empirical evidence on the extent that increased social support explains why some groups tend to report better mental health in ethnically dense neighbourhoods.

Only two studies have been identified that have examined this proposition, one in the UK and another in the US, with equivocal results [10 11]. More broadly, studies of ethnic density and mental health have been mostly based upon adolescents and adults of child-bearing age in European and North American datasets [10-18]. Few studies have been conducted on adults in middle to older age. **This is especially the case in Australia (with the exception of an earlier ecological study [19]),** which is surprising when one considers that, of the 22.6 million population, over one quarter were born outside Australia [20] and 50% of whom originated from non-English-speaking countries [21].

Australian cities are some of the most ethnically diverse in the world [22] and often contain substantial residential clustering of ethnic groups [23-25]. Contrasting migration histories and residential patterns of ethnic groups means that one cannot assume association between ethnic density and mental health reported in Europe and North America generalises to the Australian context. Therefore, more research is required not only to further understand the mechanisms underlying ethnic density effects, but also to identify the extent that ethnic density may be beneficial to mental health in other ethnically diverse countries like Australia. In this paper we attempt to achieve both of these aims, in addition to an examination of ethnic differences in mental health and the role of social support more generally, through an analysis of a large number of ethnic groups and four measures of social interactions in an Australian cohort of adults.

METHOD

Study population

The 45 and Up study [26] is a large scale cohort of 267,151 residents aged 45 and over in New South Wales ('NSW', the most populous state in Australia). A baseline questionnaire covering a range of health and social issues was distributed to a random sample of adults listed in the Medicare Australia database between 2006 and 2009 inclusive. Medicare Australia is the database through which national healthcare is provided for Australian citizens and permanent residents, as well some temporary residents and refugees [26]. Response to the questionnaire was 18%, which is low, though previous research has suggested that results from the 45 and Up Study are broadly comparable to those derived from 'representative' samples [27]. The University of New South Wales Human Research Ethics Committee approved The 45 and Up Study. Further details including the baseline questionnaire are available to download from www.45andUp.org.au.

Ethnicity status was derived from the first (of up to two) responses to a question on self-reported ancestry ('*What is your ancestry?*'). Secondary responses to this question were not used in the definition of ethnicity as they were not available in our dataset. We focused on the 19 largest groups: Australian, English, Scottish, Welsh, Irish, Danish, French, Swiss, German, Dutch, Spanish, Italian, Greek, Polish, Maltese, Lebanese, Croatian, Indian, and Chinese. Large sample sizes allowed for stratification of each group by country of birth (assessed by the question '*in which country were you born?*') to address healthy-migrant effects. We retained all participants born in Australia (n=179,712), all participants of Australian ethnicity born outside Australia (n=1,336), and participants of non-Australian ethnic groups born in their ethnic-country of origin (n=33,739). Participants of non-Australian ethnic groups born elsewhere (i.e. not Australia or their ethnic-country of origin) were omitted from the sample (n=33,574) for substantive and practical reasons. Non-Australian ethnic groups born overseas and not in the ethnic-country of origin were heterogeneous by definition, which made it difficult to meaningfully interpret any results for to these participants. Furthermore, in practical terms, the sample sizes of many of these groups were small, which also reduced the potential to draw reliable statistical inference. We also omitted all participants missing a postcode identifier (n=263) and those missing a valid outcome measure (n=7,011). Missing data for independent variables was resolved via imputing the mean of the observed values, retaining an overall sample size of n=226,487.

Psychological distress

We used the Kessler Psychological Distress Scale (K10) to evaluate mental health status [28 29]. The K10 measures symptoms of psychological distress experienced over the past four weeks, including feeling tired for no reason, nervous, hopeless, restless, depressed, sad and worthless. Participants had five choices for each of the ten questions (none of the time =1, a little of the time =2, some of the time =3, most of the time =4, all of the time=5) and these were summed to give the overall score. The K10 have been previously used to gauge levels of psychological distress across different countries and ethnic groups [29-32]. We constructed a binary variable wherein a score of 22 or more identified participants with a high risk of psychological distress [33]. The K10 has been used in this binary manner, with 22 as the cut-point, in previous published analyses of The 45 and Up Study [34-36].

Other individual-level measures

Social interactions were measured using four questions from the shortened version of the Duke Social Support Index [37]. Three of the questions tested the number of times in the past week a participant: i) spent time with friends or family they did not live with; ii) talked to someone (friends, relatives or others) on the telephone; iii) attended meetings at social clubs or religious groups. The final question asked participants how many people outside their home, but within one hour travel-time, did they feel close to or could rely on. Previous work has constructed a composite indicator of social support from responses to these questions [38 39], though we analysed each one separately in line with recent studies which have demonstrated that some are more important than others [40].

We also accounted for other individual-level variables (self-reported) which are known to correlate with mental health. These included: age, gender, physical activity, smoking status, Body Mass Index (BMI), highest educational qualifications, economic status, annual household income, couple status, and whether language(s) other than English were spoken at home.

Neighbourhood-level measures

This study used Census Collection Districts (CCD) to define neighbourhoods. With a mean of 225 residents [41], CCDs were the smallest geographical scale for which 2006 Census data was made available [42]. However, 9% of participants in The 45 and Up Study were missing a valid CCD. In line with a previous study using the same data [43], we assigned those missing a CCD with a pseudo-CCD according to the location of the population-weighted postcode centroid as nearly 100% had a postcode identifier. Therefore, 100% of the sample could be assigned neighbourhood measures and clustering within regression models could be operationalized at the CCD level.

We constructed the measure of own-group ethnic density from 2006 Census data. The Census question on ancestry (a surrogate for ethnicity in our study) was very similar to that used in the 45 and Up Study ("What is the person's ancestry?"). The number of people within a CCD pertaining to each participant's ethnic group was divided the total usual resident population. For example, Chinese participants (regardless of their country of birth) were assigned the percentage of the population in their CCD who self-identified as Chinese.

Other neighbourhood measures included local affluence and geographical remoteness. We used the Socio-Economic Index for Areas (SEIFA) 'Index of Relative Socio-Economic Advantage/Disadvantage' [44] to measure local affluence. This is a variable derived by the Australian Bureau of Statistics (ABS) using Census variables which relate to advantage and disadvantage, including household income and educational qualifications. This indicator was expressed in percentiles; higher percentiles indicate more affluent areas. Geographical remoteness was measured using the 'Accessibility/Remoteness Index of Australia' (ARIA) [45]. ARIA is a score ranging from 0 to 15, with scores of 2.4 and over used to distinguish between urban and inner regions (<2.4) and rural or remote (>=2.4).

Statistical analysis

The study population was first assessed using descriptive statistics. Measures of ethnic density were mapped across NSW. To investigate ethnic differences in psychological distress, multilevel logistic regression was used to account for the clustering of participants within CCDs [46]. The sample was clustered within 11,621 CCDs (20 participants per CCD on average). CCDs accounted for 3.3% of the variation in psychological distress within a 'null' two-level multilevel model. A categorical variable identifying ethnic groups stratified by country of birth was fitted in this model, which was then adjusted for age and gender. We proceeded to test whether any ethnic differences in psychological distress remained significant after controlling for social interactions, other individual-level variables, local affluence and geographical remoteness. Multilevel logit regression was fitted to ethnic and country of birth-specific groups (i.e. stratified models) to investigate association between psychological distress and own-group ethnic density. To assess whether these associations could be

explained by social interactions, we first tested the extent of correlation between each measure and own-group ethnic density using negative-binomial regression (to account for the skewed distribution of the social interaction variables). Social interactions were then fitted into the logit models, followed by individual-level variables, local affluence and geographical remoteness. Interaction terms were fitted to test for potential synergistic effects between ethnic density and other neighbourhood variables. Statistically significant associations were identified using the log-likelihood ratio test ($p < 0.05$). All analyses were conducted in STATA 12.

RESULTS

Figure 1 reports differences in the age- and gender-adjusted prevalence of psychological distress by ethnicity and country of birth. The rate of high psychological distress was 11% for Australians born in Australia. In comparison, this risk was far higher for some groups, for example, 33% for the Lebanese born in Lebanon, but much lower for others, such as the Swiss born in Switzerland at 4%.There was no consistent effect of migrant status on the risk of psychological distress. For example, the prevalence of psychological distress among Croatians born in Croatia was 14.3% higher than their Australian born Croatian peers. In contrast, no substantive difference in the prevalence of psychological distress was reported among the Chinese, whether born in Australia (12.8%) or China (12.9%), and the Danish born in Australia had twice the risk of their Danish born contemporaries (10% to 5% respectively).

<Figure 1 here>

Table 1 reports the percentage of each ethnic and country of birth group within the lowest quartile of the four social interactions measures. P-values for comparisons between ethnic and country of birth groups for each social interaction variable were calculated using logistic regression. Compared to their Australian-born peers, those born within their ethnic country of origin tended to be more prevalent in the lowest quartile of every measure of social interactions. For the variable denoting how many people a person felt they could rely on, within group differences were notably wide between the Australian-born and those born in the ethnic country of origin for the French (34.1%, 52%), Polish (37.8%, 51%), Lebanese (26.2%, 45.7%) and Chinese (32.8%, 56.7%).

Table 1: Ethnic and country of birth differences in social interactions; percentage in the lowest quartile for each measure of social interactions

Ethnic group, country of birth	N (%)	Social interactions			
		Less likely to spend time with friends/family	*Less likely to talk to someone*	*Less likely to go to social clubs*	*Few people can depend on*
Australia, Australia	61,848 (27.3)	35.9 (35.51, 36.30)	26.1 (25.72, 26.45)	42.1 (41.68, 42.51)	30.5 (30.10, 30.88)
Australian, Not Australia	1,383 (0.6)	37.9 (35.37, 40.54)	30.2 (27.85, 32.73)***	37.9 (35.37, 40.59)***	36.7 (34.15, 39.28)***
English, Australia	50,480 (22.3)	35.6 (35.16, 36.03)	25.5 (25.06, 25.86)*	41.3 (40.89, 41.80)*	30.1 (29.64, 30.49)
English, UK	16,356 (7.2)	41.4 (40.66, 42.21)***	28.5 (27.82, 29.24)***	43.9 (43.15, 44.73)***	37.9 (37.17, 38.71)***
Scottish, Australia	21,745 (9.6)	35.1 (34.47, 35.78)*	24.6 (24.06, 25.24)***	40.5 (39.86, 41.21)***	29.2 (28.57, 29.81)***
Scottish, UK	3,759 (1.7)	37.8 (36.28, 39.43)*	27.8 (26.32, 29.23)*	42.9 (41.28, 44.53)	35.8 (34.26, 37.37)***
Welsh, Australia	1,265 (0.6)	36.6 (33.99, 39.38)	25.0 (22.67, 27.51)	40.3 (37.58, 43.11)	30.0 (27.48, 32.58)
Welsh, UK	835 (0.4)	42.4 (39.06, 45.87)***	28.9 (25.89, 32.12)	44.6 (41.14, 48.05)	38.0 (34.68, 41.35)***
Irish, Australia	33,360 (14.7)	35.0 (34.52, 35.58)**	24.1 (23.58, 24.53)***	39.7 (39.20, 40.30)***	30.4 (29.91, 30.94)
Irish, Ireland	1,048 (0.5)	40.9 (37.89, 43.92)***	27.5 (24.90, 30.34)	36.7 (33.71, 39.69)***	36.3 (33.37, 39.25)***
Danish, Australia	695 (0.3)	36.4 (32.84, 40.09)	24.7 (21.58, 28.11)	37.7 (34.11, 41.46)*	30.2 (26.88, 33.74)
Danish, Denmark	178 (0.1)	49.0 (41.63, 56.43)***	34.2 (27.55, 41.57)*	55.3 (47.76, 62.56)***	42.3 (35.15, 49.78)***
French, Australia	1,195 (0.5)	37.9 (35.18, 40.77)	26.3 (23.78, 28.92)	44.1 (41.20, 46.95)	34.1 (31.46, 36.87)**
French, France	237 (0.1)	47.1 (40.76, 53.58)***	29.9 (24.30, 36.10)	53.4 (46.92, 59.85)***	52.0 (45.51, 58.36)***
Swiss, Australia	163 (0.1)	40.9 (33.48, 48.67)	23.5 (17.62, 30.70)	49.7 (41.86, 57.48)	34.5 (27.59, 42.20)
Swiss, Switzerland	224 (0.1)	49.6 (43.01, 56.23)***	35.8 (29.66, 42.36)***	51.1 (44.46, 57.77)***	45.1 (38.62, 51.76)***
German, Australia	9,894 (4.4)	36.1 (35.18, 37.11)	26.4 (25.49, 27.27)	41.4 (40.41, 42.41)	31.0 (30.12, 31.97)
German, Germany	2,073 (0.9)	48.0 (45.82, 50.19)***	35.4 (33.33, 37.54)***	50.6 (48.38, 52.79)***	45.8 (43.63, 47.99)***
Dutch, Australia	1,487 (0.7)	35.0 (32.61, 37.43)	27.8 (25.57, 30.11)	41.6 (39.09, 44.15)	31.2 (28.93, 33.65)
Dutch, Netherlands	2,451 (1.1)	40.8 (38.88, 42.85)***	30.7 (28.87, 32.57)***	42.4 (40.39, 44.43)	37.7 (35.78, 39.68)***
Spanish, Australia	316 (0.1)	40.8 (35.42, 46.36)	28.6 (23.72, 33.93)	46.6 (41.05, 52.22)	30.0 (25.15, 35.25)
Spanish, Spain	158 (0.1)	45.5 (37.82, 53.48)*	31.4 (24.55, 39.12)	53.9 (45.89, 61.72)**	47.3 (39.57, 55.25)***
Italian, Australia	3,259 (1.4)	35.5 (33.88, 37.18)	25.8 (24.33, 27.34)	41.2 (39.49, 42.93)	32.0 (30.42, 33.66)
Italian, Italy	1,922 (0.9)	37.4 (35.21, 39.62)	29.5 (27.48, 31.58)***	48.1 (45.84, 50.43)***	36.5 (34.36, 38.75)***
Greek, Australia	1,072 (0.5)	34.1 (31.36, 37.03)	21.2 (18.92, 23.75)***	44.0 (40.98, 47.03)	30.1 (27.44, 32.96)
Greek, Greece	696 (0.3)	38.6 (35.02, 42.39)	30.5 (27.14, 34.09)**	45.8 (42.01, 49.61)	44.4 (40.63, 48.14)***
Polish, Australia	1,111 (0.5)	39.0 (36.14, 41.91)*	28.7 (26.05, 31.41)	41.8 (38.86, 44.72)	37.8 (34.94, 40.70)***
Polish, Poland	471 (0.2)	47.5 (42.98, 52.12)***	38.7 (34.31, 43.27)***	46.4 (41.80, 51.06)	51.0 (46.37, 55.52)***
Maltese, Australia	675 (0.3)	35.0 (31.53, 38.66)	28.8 (25.49, 32.29)	41.1 (37.47, 44.93)	29.2 (25.94, 32.79)
Maltese, Malta	715 (0.3)	38.7 (35.19, 42.43)	30.1 (26.78, 33.57)*	38.9 (35.29, 42.59)	38.9 (35.31, 42.57)***
Lebanese, Australia	461 (0.2)	34.0 (29.83, 38.49)	23.5 (19.81, 27.54)	37.5 (33.16, 42.06)*	26.2 (22.35, 30.39)*
Lebanese, Lebanon	567 (0.3)	30.9 (27.24, 34.78)*	29.6 (25.99, 33.43)	41.4 (37.34, 45.56)	45.7 (41.56, 49.89)***
Croatian, Australia	218 (0.1)	37.3 (31.12, 43.93)	22.9 (17.83, 28.92)	44.9 (38.34, 51.74)	34.3 (28.32, 40.93)
Croatian, Croatia	349 (0.2)	43.4 (38.20, 48.74)**	40.8 (35.63, 46.14)***	47.3 (42.00, 52.68)	48.0 (42.75, 53.36)***
Indian, Australia	213 (0.1)	39.0 (32.60, 45.72)	20.8 (15.90, 26.69)	43.6 (36.97, 50.42)	32.3 (26.38, 38.90)
Indian, India	668 (0.3)	47.7 (43.91, 51.61)***	26.3 (23.12, 29.66)	26.5 (23.29, 29.88)***	39.4 (35.66, 43.18)***
Chinese, Australia	690 (0.3)	39.3 (35.68, 43.03)	28.7 (25.41, 32.24)	40.5 (36.80, 44.23)	32.8 (29.36, 36.41)
Chinese, China	2,250 (1.0)	53.5 (51.40, 55.62)***	40.5 (38.42, 42.57)***	42.5 (40.42, 44.59)	56.7 (54.62, 58.82)***

*** p < 0.001; ** p < 0.01; * p < 0.05 (from Australian, Australia)

Table 2 reports results from multilevel logit regression. Model 1 reports ethnic and country of birth differences in psychological distress, adjusted for age and gender (sensu Figure 1). We adjusted this model for each social interaction variable individually, and then simultaneously (Model 2). Higher quartiles of each social interaction variable were associated with a lower risk of psychological distress; especially that denoting the number of people that can be relied on (highest quartile odds ratio: 0.36, 95% confidence interval: 0.34, 0.38). Social interactions only fully explained the higher risk of psychological distress experienced by the Chinese born in China (as denoted by statistical

significance). However, there were other instances where odds ratios were attenuated, though remained significant, and this was often for people born outside Australia, such as the Lebanese born in Lebanon (OR=3.97 to 3.67) and the Croatians born in Croatia (OR=2.70 to 2.30). Adjusting for all other individual-level characteristics, neighbourhood affluence and geographical remoteness (Model 3) had a more substantive effect on the ethnic differences (OR=3.67 to 2.11 for the Lebanese born in Lebanon; OR=2.30 to 1.84 for the Croatians born in Croatia).

Table 2: Ethnic and country of birth group differences in the risk of psychological distress, adjusted for social interactions variables and other individual and neighbourhood characteristics

Ethnicity, country of birth	Model 1	Model 2	Model 3
	Odds Ratio (95% Confidence Interval)		
Australian, Australia	1	1	1
Australian, Not Australia	1.83 (1.59, 2.10)***	1.73 (1.50, 1.99)***	1.57 (1.36, 1.82)***
English, Australia	0.93 (0.90, 0.97)***	0.94 (0.90, 0.98)***	0.96 (0.92, 1.00)*
English, UK	0.83 (0.78, 0.88)***	0.75 (0.71, 0.80)***	0.82 (0.77, 0.87)***
Scottish, Australia	0.89 (0.84, 0.93)***	0.90 (0.86, 0.95)***	0.96 (0.91, 1.01)
Scottish, UK	0.81 (0.72, 0.90)***	0.76 (0.68, 0.85)***	0.82 (0.73, 0.92)***
Welsh, Australia	1.10 (0.93, 1.31)	1.12 (0.94, 1.33)	1.19 (1.00, 1.42)
Welsh, UK	0.82 (0.65, 1.04)	0.75 (0.60, 0.95)*	0.84 (0.66, 1.07)
Irish, Australia	0.95 (0.91, 0.99)*	0.96 (0.92, 1.01)	0.99 (0.95, 1.04)
Irish, Ireland	0.93 (0.76, 1.13)	0.87 (0.71, 1.06)	0.92 (0.75, 1.12)
Danish, Australia	0.90 (0.70, 1.15)	0.91 (0.71, 1.17)	0.94 (0.73, 1.21)
Danish, Denmark	0.43 (0.22, 0.84)*	0.36 (0.18, 0.71)**	0.38 (0.19, 0.77)**
French, Australia	1.04 (0.87, 1.24)	1.01 (0.84, 1.21)	0.99 (0.83, 1.19)
French, France	1.08 (0.73, 1.60)	0.87 (0.58, 1.29)	1.00 (0.67, 1.51)
Swiss, Australia	1.01 (0.62, 1.65)	1.00 (0.61, 1.63)	1.14 (0.69, 1.88)
Swiss, Switzerland	0.33 (0.17, 0.65)***	0.27 (0.14, 0.53)***	0.33 (0.17, 0.65)***
German, Australia	1.12 (1.05, 1.19)***	1.11 (1.04, 1.19)***	1.10 (1.02, 1.17)**
German, Germany	0.98 (0.86, 1.13)	0.82 (0.71, 0.94)**	0.87 (0.75, 1.00)*
Dutch, Australia	1.03 (0.88, 1.22)	1.02 (0.87, 1.20)	1.07 (0.90, 1.27)
Dutch, Netherlands	0.96 (0.85, 1.09)	0.88 (0.78, 1.01)	0.91 (0.80, 1.04)
Spanish, Australia	1.08 (0.77, 1.52)	1.08 (0.76, 1.52)	0.92 (0.64, 1.33)
Spanish, Spain	1.35 (0.87, 2.11)	1.14 (0.73, 1.79)	1.06 (0.67, 1.67)
Italian, Australia	1.05 (0.94, 1.18)	1.04 (0.93, 1.17)	1.07 (0.96, 1.21)
Italian, Italy	1.79 (1.59, 2.02)***	1.68 (1.49, 1.89)***	1.46 (1.29, 1.65)**
Greek, Australia	1.07 (0.88, 1.29)	1.08 (0.89, 1.30)	1.11 (0.91, 1.35)
Greek, Greece	2.04 (1.69, 2.46)***	1.81 (1.50, 2.19)***	1.33 (1.10, 1.62)**
Polish, Australia	1.17 (0.98, 1.40)	1.10 (0.92, 1.32)	1.15 (0.95, 1.39)
Polish, Poland	1.89 (1.51, 2.37)***	1.54 (1.22, 1.94)***	1.64 (1.30, 2.08)***
Maltese, Australia	1.26 (1.01, 1.57)*	1.27 (1.01, 1.59)*	1.11 (0.88, 1.41)
Maltese, Malta	1.71 (1.41, 2.09)***	1.59 (1.30, 1.94)***	1.19 (0.97, 1.46)
Lebanese, Australia	1.13 (0.85, 1.50)	1.22 (0.92, 1.62)	1.31 (0.98, 1.75)
Lebanese, Lebanon	3.97 (3.30, 4.76)***	3.67 (3.04, 4.42)***	2.11 (1.73, 2.57)***
Croatian, Australia	0.97 (0.63, 1.49)	0.94 (0.61, 1.46)	1.00 (0.64, 1.56)
Croatian, Croatia	2.70 (2.11, 3.46)***	2.30 (1.78, 2.96)***	1.84 (1.42, 2.39)***
Indian, Australia	1.86 (1.31, 2.63)***	1.88 (1.33, 2.68)***	1.64 (1.14, 2.35)**
Indian, India	1.13 (0.89, 1.43)	1.07 (0.84, 1.36)	1.43 (1.12, 1.83)**
Chinese, Australia	1.18 (0.94, 1.48)	1.16 (0.92, 1.45)	1.18 (0.93, 1.50)
Chinese, China	1.19 (1.05, 1.35)**	0.90 (0.79, 1.02)	1.05 (0.92, 1.20)
Number of occasions spent with friends or family			
Quartile 1 (Low)		1	1
Quartile 2 (Low to Moderate)		0.77 (0.74, 0.81)***	0.78 (0.75, 0.82)***
Quartile 3 (Moderate to High)		0.80 (0.77, 0.83)***	0.78 (0.75, 0.81)***
Quartile 4 (High)		1.00 (0.97, 1.04)	0.89 (0.85, 0.92)***
Number of telephone conversations			
Quartile 1 (Low)		1	1
Quartile 2 (Low to Moderate)		0.77 (0.74, 0.80)***	0.82 (0.79, 0.85)***
Quartile 3 (Moderate to High)		0.79 (0.76, 0.82)***	0.83 (0.80, 0.87)***
Quartile 4 (High)		0.78 (0.75, 0.81)***	0.85 (0.82, 0.88)***

Number of visits to social clubs		
Quartile 1 (Low)	1	1
Quartile 2 (Low to Moderate)	0.75 (0.72, 0.78)***	0.86 (0.83, 0.90)***
Quartile 3 (Moderate to High)	0.77 (0.74, 0.80)***	0.88 (0.84, 0.91)***
Quartile 4 (High)	0.95 (0.92, 0.98)**	1.01 (0.97, 1.04)
Number of people that can be relied on		
Quartile 1 (Low)	1	1
Quartile 2 (Low to Moderate)	0.58 (0.56, 0.61)***	0.66 (0.63, 0.68)***
Quartile 3 (Moderate to High)	0.48 (0.47, 0.50)***	0.56 (0.54, 0.58)***
Quartile 4 (High)	0.36 (0.34, 0.38)***	0.44 (0.42, 0.46)***

* p < 0.05; ** p < 0.01; *** p < 0.001
Model 1: Multilevel logit regression, adjusted for age and gender
Model 2: Model 1 + social interactions
Model 3: Model 2 + other individual-level variables, neighbourhood affluence and geographical remoteness

Figure 2 illustrates the ethnic and country of birth group differences in own-group ethnic density. Regardless of whether participants were born in Australia or the UK, those identifying as Australian (32.6%) or English (35.1%) ethnicities lived in the most ethnically dense neighbourhoods. Compared to the Australians and the English, the clustering of other ethnic groups in NSW was much lower. The highest mean ethnic density for non-Australian and non-English groups was for the Chinese born in China at 14.9%, whereas the lowest was for Australian born Swiss at 0.1%. There was evidence of heterogeneity of mean ethnic density within some groups. For example, Italians born in Australia had a mean of ethnic density of 4.9% but Italian-born Italians had 7.7%. Similar patterns were observed for Greeks, the Chinese and the Lebanese.

<Figure 2 here>

For the next stage of analysis we investigated the level of association with own-group ethnic density. This necessitated stratification of the sample by ethnic and country of birth group to match each individual with the relevant ethnic density measure. For example, Chinese ethnic density was matched to Chinese individuals (irrespective of whether they were born in China or Australia). We conducted these analyses for all groups, but due to space constraints, we focus our report on groups that have a mean ethnic density of 2% or more: Australians, English, Scottish, Irish, German, Italian, Greek, Lebanese, and Chinese. Table 3 reports mostly weak and positive or null (i.e. p>0.05) correlations between own group ethnic density and each of the social interactions variables. The most consistent set of correlations were for the social interactions variable which indicated how many people could be relied on within a one-hour travel-time.

Table 3: Correlations between own group ethnic density and each of the social interactions variables, stratified by ethnic and country of birth group

Ethnic group, country of birth	How many times last week did you:			How many people outside your home, within one hour of travel, do you feel you can depend on
	Spend time with friends/family who do not live with you	*Talk to someone (friends, relatives or others)*	*Go to meetings of social clubs, religious groups or other groups you belong to*	
Australia, Australia	0.012**	-0.017***	-0.012**	0.008*
Australian, Not Australia	-0.010	-0.053*	0.005	-0.001
English, Australia	0.019***	0.001	0.013**	-0.001
English, UK	0.0156	-0.010	0.029**	0.006
Scottish, Australia	0.007	0.008	0.001	0.014*
Scottish, UK	0.036*	0.029	-0.007	0.031
Irish, Australia	0.005	0.009	-0.001	0.005
Irish, Ireland	-0.014	-0.012	0.019	-0.027
German, Australia	-0.002	-0.016	0.016	0.024*
German, Germany	-0.022	0.020	-0.004	0.057**
Italian, Australia	0.018	-0.028	-0.035*	0.049**
Italian, Italy	0.028	0.025	0.045	0.086**
Greek, Australia	0.066*	-0.032	-0.028	0.117**
Greek, Greece	0.012	-0.026	0.052	0.017
Lebanese, Australia	-0.033	0.047	0.055	0.273***
Lebanese, Lebanon	-0.029	0.009	-0.061	-0.031
Chinese, Australia	0.048	-0.015	0.008	-0.059
Chinese, China	0.036	0.033	0.082**	-0.007

* p < 0.05; ** p < 0.01; *** p < 0.001

Table 4 reports the results of these ethnic and county of birth group specific models. Model 1 fitted the association between psychological distress and own-group ethnic density, adjusted for age and gender. A 1% increase in own-group ethnic density appeared protective against psychological distress for the English born in UK, and Australian-born Scottish, Irish and Chinese. Unexpectedly, increasing ethnic density was associated with a higher risk of psychological distress among Australians born in Australia. This model was adjusted by the social interactions variables (Model 2), but the associations between ethnic density and psychological distress persisted. Further adjustment for other individual-level variables, local affluence and geographical remoteness (Model 3) had a more substantial attenuating influence on the ethnic density odds ratios and 95% confidence intervals, except that for the English born in the UK and the overseas-born Australians. We did not find any evidence of interactions between ethnic density and any other independent variables in our models. **Results from the imputed data set were similar to those from complete-case analysis.**

Table 4: Association between own-group ethnic density and psychological distress by ethnic group, adjusting for social interactions and other individual and neighbourhood characteristics: Odds Ratios (95% Confidence Intervals)

	Model 1	Model 2	Model 3

	OR (95% CI)		
Australian, Australia	1.011 (1.008, 1.014)***	1.010 (1.007, 1.014)***	1.000 (0.997, 1.004)
Australian, not Australia	0.974 (0.959, 0.988)***	0.976 (0.961, 0.991)**	0.973 (0.955, 0.991)**
English, Australia	1.000 (0.996, 1.003)	1.000 (0.996, 1.004)	0.998 (0.994, 1.002)
English, UK	0.992 (0.986, 0.999)*	0.993 (0.987, 1.000)*	0.992 (0.985, 0.999)*
Scottish, Australia	0.972 (0.945, 1.000)*	0.979 (0.951, 1.007)	0.986 (0.957, 1.015)
Scottish, UK	0.982 (0.913, 1.057)	0.991 (0.921, 1.067)	1.002 (0.929, 1.081)
Irish, Australia	0.977 (0.962, 0.992)**	0.980 (0.965, 0.995)**	0.998 (0.983, 1.014)
Irish, Ireland	0.940 (0.861, 1.026)	0.946 (0.863, 1.038)	0.965 (0.868, 1.073)
German, Australia	0.987 (0.949, 1.028)	0.994 (0.954, 1.036)	1.000 (0.959, 1.042)
German, Germany	0.999 (0.901, 1.107)	1.004 (0.905, 1.115)	1.002 (0.895, 1.121)
Italian, Australia	0.991 (0.973, 1.009)	0.994 (0.977, 1.012)	1.013 (0.992, 1.034)
Italian, Italy	0.998 (0.985, 1.011)	1.002 (0.989, 1.016)	1.003 (0.988, 1.017)
Greek, Australia	0.983 (0.943, 1.024)	0.994 (0.955, 1.035)	1.006 (0.963, 1.052)
Greek, Greece	1.009 (0.987, 1.032)	1.011 (0.989, 1.034)	1.005 (0.979, 1.032)
Lebanese, Australia	1.008 (0.954, 1.065)	1.038 (0.981, 1.099)	0.983 (0.913, 1.057)
Lebanese, Lebanon	1.025 (0.999, 1.051)	1.023 (0.995, 1.051)	1.012 (0.983, 1.042)
Chinese, Australia	0.897 (0.812, 0.990)*	0.861 (0.760, 0.975)*	0.884 (0.699, 1.116)
Chinese, China	1.003 (0.992, 1.014)	1.004 (0.993, 1.014)	0.999 (0.988, 1.011)

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Model 1: Adjusted for age and gender

Model 2: Model 1 + social interactions

Model 3: Model 2 + individual characteristics, neighbourhood affluence and geographical remoteness

DISCUSSION

This paper examined the relationship between ethnic density and psychological distress in one of the most ethnic diverse areas of Australia. We found substantive heterogeneity in the risk of psychological distress between and within ethnic groups. Ethnic differences in social interactions, individual and neighbourhood characteristics did not explain the ethnic differences in the risk of psychological distress. More social interactions were associated with a lower risk of psychological distress, especially the number of people study participants felt they could rely on. Increasing own-group ethnic density was associated more social interactions and less psychological distress for some ethnic groups, but not all. However, it was the characteristics of individuals and the neighbourhoods in which they lived, not the social interactions, which mostly explained the ethnic density effects on psychological distress. Only the English born in the UK and the overseas-born Australians appeared to benefit from ethnic density after controlling for all other characteristics.

Although there are many studies on ethnic density and mental health [4 6 10-18], only two others have tested whether this relationship is explained by social interactions. A UK study [10] found a lower risk of common mental disorders for the Irish and for the Bangladeshi groups they studied in more

ethnically dense neighbourhoods. This was not fully explained by measures of practical and emotional social support. Contrary to the ethnic density hypothesis, this study also reported significantly higher risk of common mental disorders among white British in ethnically dense neighbourhoods. A study in the US [11] also showed the benefits of living in a higher own-ethnic group density neighbourhoods for the emotional well-being of Black and Hispanic groups. Measures of personal and neighbourhood social support partially explained the relationship for Blacks but not among Hispanics. Therefore, despite using contrasting measures of mental health and social interactions for different ethnic groups in the UK, US and Australia, our findings are consistent wherein social interactions only played a weak role in explaining the ethnic density effect on mental health.

A particular strength of our study includes the large sample sizes for many different ethnic groups; more than has been possible to analyse in previous studies [4]. This allowed stratification by country of birth, which afforded new insights into the heterogeneity of mental health, social interactions and ethnic density within groups. It is noteworthy that levels of ethnic density varied considerably by country of birth within some ethnic groups (e.g. the Chinese), though not all (e.g. the English). Given the general supposition that higher levels of ethnic density are better for mental health, it could be argued that for many groups, levels of ethnic density do not achieve a sufficient concentration necessary for health promotion in this sample. This hypothesis is not convincing, however, when one considers that no association between ethnic density and psychological distress was found for the Chinese born in China, who reported a mean ethnic density of approximately 15% and a maximum of nearly 80%, but there was an association among the Chinese born in Australia, for whom the mean ethnic density was about 5% and a maximum of around 63%. Likewise, there appeared to be a benefit of ethnic density for the UK-born English, but not the English born in Australia, despite having very similar levels of own-group ethnic density. As such, it would appear that a more nuanced approach may be required in future, using other sources of administrative data and qualitative methods to examine what it is about ethnically dense neighbourhoods which promote better mental health in some ethnic groups, but not all.

Our measures of psychological distress and social interactions have been widely validated. The small geographical scale (CCD) used to construct ethnic density provided a more accurate description of local circumstances than previous work which has relied upon larger spatial scales, helping to identify small 'pockets' of ethnic density and affluence that would otherwise have been hidden [47]. The focus on small scale geography is an advantage, though our study shares a common limitation among others of this genre in the reliance upon administrative boundaries, which are unlikely to perfectly correlate with residents' perceptions of neighbourhood [48]. **Such perceptions may vary depending upon location, circumstances and individual characteristics; including ethnicity. Therefore, it would appear that future research may need to explore the ethnic density hypothesis with customised measures of neighbourhood scale.**

It is reasonable to expect that social support from the neighbourhood would be reflected in the four measures of social interactions used in the study, albeit imperfectly. Social clubs attended, for example, may be located in the neighbourhood and many of the people who can be relied on within one hour of travel may in fact live much closer. The limitation, however, is that the questions used in the 45 and Up Study did not ask participants to distinguish how many of these interactions occurred within versus outside the neighbourhood in which they lived. It would be useful for further

work, therefore, to examine indicators which specify neighbourhood parameters within the question. Another limitation was that the 45 and Up Study was sampled from the Medicare Australia database which mainly includes Australian citizens and migrants on permanent residency visas. Only some migrants on temporary visas are included on this scheme and this is likely to mean that some ethnic minorities were not represented in our study. Representativeness is also a concern for a dataset wherein the response rate was only 18%, although comparisons between the 45 and Up Study and a 'representative' dataset have helped to alleviate these concerns to some extent [27]. **However, the comparisons in the aforementioned study did find heterogeneity between psychological distress and English spoken at home, and did not have an explicit focus on ethnic differences. Although regression methods are robust to missing data assumptions, there is still the possibility of bias.** The 45 and Up Study asked participants about Aboriginal and Torres Strait Islander origin, though responses to this variable were not available for this investigation and are the focus of a follow-up study. Many studies have suggested that spatial variation in the experiences of racism could help to explain the ethnic density effect [14 16]. Although we had no measure of racism in our study, virtually all benefits of ethnic density were already explained by other individual characteristics. Finally, our study represents only people 45 years and older, so it cannot discount the possibility of different patterns for younger age groups.

CONCLUSION

Ethnic groups in New South Wales, Australia, experience substantively different risks of psychological distress. These differences also align by country of birth, though there is no consistent pattern. Increasing social interactions, particularly those which help people to develop relationships with others they can depend on in times of need, are beneficial for mental health regardless of ethnicity and country of birth. In comparison, the ethnic density of where people live was protective only for the UK-born English and the overseas-born Australians.

ACKNOWLEDGEMENTS, COMPETING INTERESTS & FUNDING

We thank all of the men and women who participated in the 45 and Up Study. The 45 and Up Study is managed by the Sax Institute in collaboration with major partner Cancer Council New South Wales; and partners the Heart Foundation (NSW Division); NSW Ministry of Health; *beyondblue: the national depression initiative*; Ageing, Disability and Home Care, NSW Family and Community Services; and the Australian Red Cross Blood Service. We acknowledge the use of 2006 census and boundary data provided by the Australian Bureau of Statistics. To preserve the anonymity of participants in The 45 and Up Study, some parameters of the Census Collector District (CCD) level data cannot be reported. This location-indexing data from the 45 and up Study is highly restricted access and will be made available only through SURE (https://www.sure.org.au/).

The authors have no competing interests.

No funding was sought for this study.

Contributorship

Feng and Astell-Burt designed the analyses for the study, which utilised an existing dataset. Feng carried out the analyses and wrote the paper draft. All authors have commented on, edited and approved the final draft.

Data sharing

No additional data is available.

LIST OF FIGURES

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Do social interactions explain ethnic differences in psychological distress and the protective effect of local ethnic density? Evidence from a cross-sectional study of 226,487 adults in middle-to-older age

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KEYWORDS

MENTAL HEALTH; ETHNICITY; MULTILEVEL MODELLING; PUBLIC HEALTH; SOCIAL EPIDEMIOLOGY

WORD COUNT: 3603

Do social interactions explain ethnic differences in psychological distress and the protective effect of local ethnic density? Evidence from a cross-sectional study of 226,487 adults in middle-to-older age

ABSTRACT

Background: A frequently proposed, but under-researched hypothesis is that ethnic density benefits mental health through increasing social interactions. We examined this hypothesis in 226,487 adults from 19 ethnic groups aged 45 years and older in Australia.

Methods: Multilevel logit regression was used to measure association between ethnicity, social interactions, own-group ethnic density and scores of 22+ on the Kessler scale of psychological distress. Self-reported ancestry was used as a proxy for ethnicity. Measures of social interactions included the number of times in the last week were: *i)* spent with friends or family participants did not live with; *ii)* talked to someone on the telephone; *iii)* attended meetings of social groups; and *iv)* how many people could be relied upon outside their home, but within one hour of travel. Per cent own-group ethnic density was measured at the Census Collection District scale.

Results: Psychological distress was reported by 11% of Australians born in Australia. The risk of experiencing psychological distress varied among ethnic minorities and by country of birth (e.g. 33% for the Lebanese born in Lebanon, compared to 4% for the Swiss born in Switzerland). These differences remained after full adjustment. Social interactions varied between ethnic groups and were associated with lower psychological distress and ethnic density. Ethnic density was associated with reduced psychological distress for some groups. This association, however, was explained by individual and neighbourhood characteristics and not by social interactions.

Conclusion: Social interactions are important correlates of mental health, but do not fully explain ethnic differences in psychological distress, nor the protective effect of own-group density.

WHAT IS ALREADY KNOWN ON THIS SUBJECT?

Ethnic differences in mental health, and the reportedly protective influence of own group ethnic density, are largely unexplained in previous studies. Social interactions are widely hypothesised as a mechanism linking ethnic density with more favourable mental health, and may also explain ethnic differences more generally. However, few studies have empirically tested these hypotheses.

WHAT THIS STUDY ADDS?

In a large cohort of Australian adults in middle-to-older age, ethnic differences in mental health were not explained by four measures of social interactions. Protective associations between ethnic density and mental health were largely explained by individual-level socioeconomic characteristics, not social interactions.

Do social interactions explain ethnic differences in psychological distress and the protective effect of local ethnic density? Evidence from a cross-sectional study of 226,487 adults in middle-to-older age

SUMMARY

Article Focus:

- Ethnic differences in mental health, and the reportedly protective influence of own group ethnic density, are largely unexplained in previous studies.
- Social interactions are widely hypothesised as a mechanism linking ethnic density with more favourable mental health, and may also explain ethnic differences more generally. However, few studies have empirically tested these hypotheses.
- We examined this hypothesis in 226,713 adults from 19 ethnic groups aged 45 years and older in Australia.

Key Messages:

- Ethnic differences in mental health persisted after full adjustment; they were not explained by four measures of social interactions, or other individual and neighbourhood characteristics.
- Protective associations between ethnic density and mental health were largely explained by individual-level socioeconomic characteristics, not social interactions.

Strengths and Limitations:

- Large samples allowed for stratification of ethnic groups to investigate differences in mental health, social interactions and ethnic density by country of birth
- The use of a very small geographical scale than in previous work allowed for the ascertainment of local 'pockets' of ethnic density, which would otherwise have been hidden if the study had been dependent upon larger spatial units
- Some of the remaining ethnic inequalities in mental health could be explained by systematic differences in the experience of racial discrimination which we were unable to control for

INTRODUCTION

The existence of ethnic differences in mental health have long been reported, though not fully explained [1-3]. It has been suggested that living in areas of higher own group ethnic density reduces the risk of psychological distress, with increased social support hypothesised to be one of the primary drivers [4]. Social norms and support networks that promote resilience to material disadvantage and sources of psychosocial stress (e.g. racism [5]) are thought to be encouraged and maintained by this geographical clustering of ethnic groups [6]; even in deprived communities [7-9]. However, there is very little empirical evidence on the extent that increased social support explains why some groups tend to report better mental health in ethnically dense neighbourhoods.

Only two studies have been identified that have examined this proposition, one in the UK and another in the US, with equivocal results [10 11]. More broadly, studies of ethnic density and mental health have been mostly based upon adolescents and adults of child-bearing age in European and North American datasets [10-18]. Few studies have been conducted on adults in middle to older age. This is especially the case in Australia (with the exception of an earlier ecological study [19]), which is surprising when one considers that, of the 22.6 million population, over one quarter were born outside Australia [20] and 50% of whom originated from non-English-speaking countries [21].

Australian cities are some of the most ethnically diverse in the world [22] and often contain substantial residential clustering of ethnic groups [23-25]. Contrasting migration histories and residential patterns of ethnic groups means that one cannot assume association between ethnic density and mental health reported in Europe and North America generalises to the Australian context. Therefore, more research is required not only to further understand the mechanisms underlying ethnic density effects, but also to identify the extent that ethnic density may be beneficial to mental health in other ethnically diverse countries like Australia. In this paper we attempt to achieve both of these aims, in addition to an examination of ethnic differences in mental health and the role of social support more generally, through an analysis of a large number of ethnic groups and four measures of social interactions in an Australian cohort of adults.

METHOD

Study population

The 45 and Up study [26] is a large scale cohort of 267,151 residents aged 45 and over in New South Wales ('NSW', the most populous state in Australia). A baseline questionnaire covering a range of health and social issues was distributed to a random sample of adults listed in the Medicare Australia database between 2006 and 2009 inclusive. Medicare Australia is the database through which national healthcare is provided for Australian citizens and permanent residents, as well some temporary residents and refugees [26]. Response to the questionnaire was 18%, which is low, though previous research has suggested that results from the 45 and Up Study are broadly comparable to those derived from 'representative' samples [27]. The University of New South Wales Human Research Ethics Committee approved The 45 and Up Study. Further details including the baseline questionnaire are available to download from www.45andUp.org.au.

Ethnicity status was derived from the first (of up to two) responses to a question on self-reported ancestry ('*What is your ancestry?*'). Secondary responses to this question were not used in the definition of ethnicity as they were not available in our dataset. We focused on the 19 largest groups: Australian, English, Scottish, Welsh, Irish, Danish, French, Swiss, German, Dutch, Spanish, Italian, Greek, Polish, Maltese, Lebanese, Croatian, Indian, and Chinese. Large sample sizes allowed for stratification of each group by country of birth (assessed by the question '*in which country were you born?*') to address healthy-migrant effects. We retained all participants born in Australia (n=179,712), all participants of Australian ethnicity born outside Australia (n=1,336), and participants of non-Australian ethnic groups born in their ethnic-country of origin (n=33,739). Participants of non-Australian ethnic groups born elsewhere (i.e. not Australia or their ethnic-country of origin) were omitted from the sample (n=33,574) for substantive and practical reasons. Non-Australian ethnic groups born overseas and not in the ethnic-country of origin were heterogeneous by definition, which made it difficult to meaningfully interpret any results for to these participants. Furthermore, in practical terms, the sample sizes of many of these groups were small, which also reduced the potential to draw reliable statistical inference. We also omitted all participants missing a postcode identifier (n=263) and those missing a valid outcome measure (n=7,011). Missing data for independent variables was resolved via imputing the mean of the observed values, retaining an overall sample size of n=226,487.

Psychological distress

We used the Kessler Psychological Distress Scale (K10) to evaluate mental health status [28 29]. The K10 measures symptoms of psychological distress experienced over the past four weeks, including feeling tired for no reason, nervous, hopeless, restless, depressed, sad and worthless. Participants had five choices for each of the ten questions (none of the time =1, a little of the time =2, some of the time =3, most of the time =4, all of the time=5) and these were summed to give the overall score. The K10 have been previously used to gauge levels of psychological distress across different countries and ethnic groups [29-32]. We constructed a binary variable wherein a score of 22 or more identified participants with a high risk of psychological distress [33]. The K10 has been used in this binary manner, with 22 as the cut-point, in previous published analyses of The 45 and Up Study [34-36].

Other individual-level measures

Social interactions were measured using four questions from the shortened version of the Duke Social Support Index [37]. Three of the questions tested the number of times in the past week a participant: i) spent time with friends or family they did not live with; ii) talked to someone (friends, relatives or others) on the telephone; iii) attended meetings at social clubs or religious groups. The final question asked participants how many people outside their home, but within one hour travel-time, did they feel close to or could rely on. Previous work has constructed a composite indicator of social support from responses to these questions [38 39], though we analysed each one separately in line with recent studies which have demonstrated that some are more important than others [40].

We also accounted for other individual-level variables (self-reported) which are known to correlate with mental health. These included: age, gender, physical activity, smoking status, Body Mass Index (BMI), highest educational qualifications, economic status, annual household income, couple status, and whether language(s) other than English were spoken at home.

Neighbourhood-level measures

This study used Census Collection Districts (CCD) to define neighbourhoods. With a mean of 225 residents [41], CCDs were the smallest geographical scale for which 2006 Census data was made available [42]. However, 9% of participants in The 45 and Up Study were missing a valid CCD. In line with a previous study using the same data [43], we assigned those missing a CCD with a pseudo-CCD according to the location of the population-weighted postcode centroid as nearly 100% had a postcode identifier. Therefore, 100% of the sample could be assigned neighbourhood measures and clustering within regression models could be operationalized at the CCD level.

We constructed the measure of own-group ethnic density from 2006 Census data. The Census question on ancestry (a surrogate for ethnicity in our study) was very similar to that used in the 45 and Up Study ("What is the person's ancestry?"). The number of people within a CCD pertaining to each participant's ethnic group was divided the total usual resident population. For example, Chinese participants (regardless of their country of birth) were assigned the percentage of the population in their CCD who self-identified as Chinese.

Other neighbourhood measures included local affluence and geographical remoteness. We used the Socio-Economic Index for Areas (SEIFA) 'Index of Relative Socio-Economic Advantage/Disadvantage' [44] to measure local affluence. This is a variable derived by the Australian Bureau of Statistics (ABS) using Census variables which relate to advantage and disadvantage, including household income and educational qualifications. This indicator was expressed in percentiles; higher percentiles indicate more affluent areas. Geographical remoteness was measured using the 'Accessibility/Remoteness Index of Australia' (ARIA) [45]. ARIA is a score ranging from 0 to 15, with scores of 2.4 and over used to distinguish between urban and inner regions (<2.4) and rural or remote (>=2.4).

Statistical analysis

The study population was first assessed using descriptive statistics. Measures of ethnic density were mapped across NSW. To investigate ethnic differences in psychological distress, multilevel logistic regression was used to account for the clustering of participants within CCDs [46]. The sample was clustered within 11,621 CCDs (20 participants per CCD on average). CCDs accounted for 3.3% of the variation in psychological distress within a 'null' two-level multilevel model. A categorical variable identifying ethnic groups stratified by country of birth was fitted in this model, which was then adjusted for age and gender. We proceeded to test whether any ethnic differences in psychological distress remained significant after controlling for social interactions, other individual-level variables, local affluence and geographical remoteness. Multilevel logit regression was fitted to ethnic and country of birth-specific groups (i.e. stratified models) to investigate association between psychological distress and own-group ethnic density. To assess whether these associations could be

explained by social interactions, we first tested the extent of correlation between each measure and own-group ethnic density using negative-binomial regression (to account for the skewed distribution of the social interaction variables). Social interactions were then fitted into the logit models, followed by individual-level variables, local affluence and geographical remoteness. Interaction terms were fitted to test for potential synergistic effects between ethnic density and other neighbourhood variables. Statistically significant associations were identified using the log-likelihood ratio test ($p < 0.05$). All analyses were conducted in STATA 12.

RESULTS

Figure 1 reports differences in the age- and gender-adjusted prevalence of psychological distress by ethnicity and country of birth. The rate of high psychological distress was 11% for Australians born in Australia. In comparison, this risk was far higher for some groups, for example, 33% for the Lebanese born in Lebanon, but much lower for others, such as the Swiss born in Switzerland at 4%.There was no consistent effect of migrant status on the risk of psychological distress. For example, the prevalence of psychological distress among Croatians born in Croatia was 14.3% higher than their Australian born Croatian peers. In contrast, no substantive difference in the prevalence of psychological distress was reported among the Chinese, whether born in Australia (12.8%) or China (12.9%), and the Danish born in Australia had twice the risk of their Danish born contemporaries (10% to 5% respectively).

<Figure 1 here>

Table 1 reports the percentage of each ethnic and country of birth group within the lowest quartile of the four social interactions measures. P-values for comparisons between ethnic and country of birth groups for each social interaction variable were calculated using logistic regression. Compared to their Australian-born peers, those born within their ethnic country of origin tended to be more prevalent in the lowest quartile of every measure of social interactions. For the variable denoting how many people a person felt they could rely on, within group differences were notably wide between the Australian-born and those born in the ethnic country of origin for the French (34.1%, 52%), Polish (37.8%, 51%), Lebanese (26.2%, 45.7%) and Chinese (32.8%, 56.7%).

Table 1: Ethnic and country of birth differences in social interactions; percentage in the lowest quartile for each measure of social interactions

Ethnic group, country of birth	N (%)	Social interactions			
		Less likely to spend time with friends/family	*Less likely to talk to someone*	*Less likely to go to social clubs*	*Few people can depend on*
Australia, Australia	61,848 (27.3)	35.9 (35.51, 36.30)	26.1 (25.72, 26.45)	42.1 (41.68, 42.51)	30.5 (30.10, 30.88)
Australian, Not Australia	1,383 (0.6)	37.9 (35.37, 40.54)	30.2 (27.85, 32.73)***	37.9 (35.37, 40.59)***	36.7 (34.15, 39.28)***
English, Australia	50,480 (22.3)	35.6 (35.16, 36.03)	25.5 (25.06, 25.86)*	41.3 (40.89, 41.80)*	30.1 (29.64, 30.49)
English, UK	16,356 (7.2)	41.4 (40.66, 42.21)***	28.5 (27.82, 29.24)***	43.9 (43.15, 44.73)***	37.9 (37.17, 38.71)***
Scottish, Australia	21,745 (9.6)	35.1 (34.47, 35.78)*	24.6 (24.06, 25.24)***	40.5 (39.86, 41.21)***	29.2 (28.57, 29.81)***
Scottish, UK	3,759 (1.7)	37.8 (36.28, 39.43)*	27.8 (26.32, 29.23)*	42.9 (41.28, 44.53)	35.8 (34.26, 37.37)***
Welsh, Australia	1,265 (0.6)	36.6 (33.99, 39.38)	25.0 (22.67, 27.51)	40.3 (37.58, 43.11)	30.0 (27.48, 32.58)
Welsh, UK	835 (0.4)	42.4 (39.06, 45.87)***	28.9 (25.89, 32.12)	44.6 (41.14, 48.05)	38.0 (34.68, 41.35)***
Irish, Australia	33,360 (14.7)	35.0 (34.52, 35.58)**	24.1 (23.58, 24.53)***	39.7 (39.20, 40.30)***	30.4 (29.91, 30.94)
Irish, Ireland	1,048 (0.5)	40.9 (37.89, 43.92)***	27.5 (24.90, 30.34)	36.7 (33.71, 39.69)***	36.3 (33.37, 39.25)***
Danish, Australia	695 (0.3)	36.4 (32.84, 40.09)	24.7 (21.58, 28.11)	37.7 (34.11, 41.46)*	30.2 (26.88, 33.74)
Danish, Denmark	178 (0.1)	49.0 (41.63, 56.43)***	34.2 (27.55, 41.57)*	55.3 (47.76, 62.56)***	42.3 (35.15, 49.78)***
French, Australia	1,195 (0.5)	37.9 (35.18, 40.77)	26.3 (23.78, 28.92)	44.1 (41.20, 46.95)	34.1 (31.46, 36.87)**
French, France	237 (0.1)	47.1 (40.76, 53.58)***	29.9 (24.30, 36.10)	53.4 (46.92, 59.85)***	52.0 (45.51, 58.36)***
Swiss, Australia	163 (0.1)	40.9 (33.48, 48.67)	23.5 (17.62, 30.70)	49.7 (41.86, 57.48)	34.5 (27.59, 42.20)
Swiss, Switzerland	224 (0.1)	49.6 (43.01, 56.23)***	35.8 (29.66, 42.36)***	51.1 (44.46, 57.77)***	45.1 (38.62, 51.76)***
German, Australia	9,894 (4.4)	36.1 (35.18, 37.11)	26.4 (25.49, 27.27)	41.4 (40.41, 42.41)	31.0 (30.12, 31.97)
German, Germany	2,073 (0.9)	48.0 (45.82, 50.19)***	35.4 (33.33, 37.54)***	50.6 (48.38, 52.79)***	45.8 (43.63, 47.99)***
Dutch, Australia	1,487 (0.7)	35.0 (32.61, 37.43)	27.8 (25.57, 30.11)	41.6 (39.09, 44.15)	31.2 (28.93, 33.65)
Dutch, Netherlands	2,451 (1.1)	40.8 (38.88, 42.85)***	30.7 (28.87, 32.57)***	42.4 (40.39, 44.43)	37.7 (35.78, 39.68)***
Spanish, Australia	316 (0.1)	40.8 (35.42, 46.36)	28.6 (23.72, 33.93)	46.6 (41.05, 52.22)	30.0 (25.15, 35.25)
Spanish, Spain	158 (0.1)	45.5 (37.82, 53.48)*	31.4 (24.55, 39.12)	53.9 (45.89, 61.72)**	47.3 (39.57, 55.25)***
Italian, Australia	3,259 (1.4)	35.5 (33.88, 37.18)	25.8 (24.33, 27.34)	41.2 (39.49, 42.93)	32.0 (30.42, 33.66)
Italian, Italy	1,922 (0.9)	37.4 (35.21, 39.62)	29.5 (27.48, 31.58)***	48.1 (45.84, 50.43)***	36.5 (34.36, 38.75)***
Greek, Australia	1,072 (0.5)	34.1 (31.36, 37.03)	21.2 (18.92, 23.75)***	44.0 (40.98, 47.03)	30.1 (27.44, 32.96)
Greek, Greece	696 (0.3)	38.6 (35.02, 42.39)	30.5 (27.14, 34.09)**	45.8 (42.01, 49.61)	44.4 (40.63, 48.14)***
Polish, Australia	1,111 (0.5)	39.0 (36.14, 41.91)*	28.7 (26.05, 31.41)	41.8 (38.86, 44.72)	37.8 (34.94, 40.70)***
Polish, Poland	471 (0.2)	47.5 (42.98, 52.12)***	38.7 (34.31, 43.27)***	46.4 (41.80, 51.06)	51.0 (46.37, 55.52)***
Maltese, Australia	675 (0.3)	35.0 (31.53, 38.66)	28.8 (25.49, 32.29)	41.1 (37.47, 44.93)	29.2 (25.94, 32.79)
Maltese, Malta	715 (0.3)	38.7 (35.19, 42.43)	30.1 (26.78, 33.57)*	38.9 (35.29, 42.59)	38.9 (35.31, 42.57)***
Lebanese, Australia	461 (0.2)	34.0 (29.83, 38.49)	23.5 (19.81, 27.54)	37.5 (33.16, 42.06)*	26.2 (22.35, 30.39)*
Lebanese, Lebanon	567 (0.3)	30.9 (27.24, 34.78)*	29.6 (25.99, 33.43)	41.4 (37.34, 45.56)	45.7 (41.56, 49.89)***
Croatian, Australia	218 (0.1)	37.3 (31.12, 43.93)	22.9 (17.83, 28.92)	44.9 (38.34, 51.74)	34.3 (28.32, 40.93)
Croatian, Croatia	349 (0.2)	43.4 (38.20, 48.74)**	40.8 (35.63, 46.14)***	47.3 (42.00, 52.68)	48.0 (42.75, 53.36)***
Indian, Australia	213 (0.1)	39.0 (32.60, 45.72)	20.8 (15.90, 26.69)	43.6 (36.97, 50.42)	32.3 (26.38, 38.90)
Indian, India	668 (0.3)	47.7 (43.91, 51.61)***	26.3 (23.12, 29.66)	26.5 (23.29, 29.88)***	39.4 (35.66, 43.18)***
Chinese, Australia	690 (0.3)	39.3 (35.68, 43.03)	28.7 (25.41, 32.24)	40.5 (36.80, 44.23)	32.8 (29.36, 36.41)
Chinese, China	2,250 (1.0)	53.5 (51.40, 55.62)***	40.5 (38.42, 42.57)***	42.5 (40.42, 44.59)	56.7 (54.62, 58.82)***

*** p < 0.001; ** p < 0.01; * p < 0.05 (from Australian, Australia)

Table 2 reports results from multilevel logit regression. Model 1 reports ethnic and country of birth differences in psychological distress, adjusted for age and gender (sensu Figure 1). We adjusted this model for each social interaction variable individually, and then simultaneously (Model 2). Higher quartiles of each social interaction variable were associated with a lower risk of psychological distress; especially that denoting the number of people that can be relied on (highest quartile odds ratio: 0.36, 95% confidence interval: 0.34, 0.38). Social interactions only fully explained the higher risk of psychological distress experienced by the Chinese born in China (as denoted by statistical

significance). However, there were other instances where odds ratios were attenuated, though remained significant, and this was often for people born outside Australia, such as the Lebanese born in Lebanon (OR=3.97 to 3.67) and the Croatians born in Croatia (OR=2.70 to 2.30). Adjusting for all other individual-level characteristics, neighbourhood affluence and geographical remoteness (Model 3) had a more substantive effect on the ethnic differences (OR=3.67 to 2.11 for the Lebanese born in Lebanon; OR=2.30 to 1.84 for the Croatians born in Croatia).

Table 2: Ethnic and country of birth group differences in the risk of psychological distress, adjusted for social interactions variables and other individual and neighbourhood characteristics

Ethnicity, country of birth	Model 1	Model 2	Model 3
	Odds Ratio (95% Confidence Interval)		
Australian, Australia	1	1	1
Australian, Not Australia	1.83 (1.59, 2.10)***	1.73 (1.50, 1.99)***	1.57 (1.36, 1.82)***
English, Australia	0.93 (0.90, 0.97)***	0.94 (0.90, 0.98)***	0.96 (0.92, 1.00)*
English, UK	0.83 (0.78, 0.88)***	0.75 (0.71, 0.80)***	0.82 (0.77, 0.87)***
Scottish, Australia	0.89 (0.84, 0.93)***	0.90 (0.86, 0.95)***	0.96 (0.91, 1.01)
Scottish, UK	0.81 (0.72, 0.90)***	0.76 (0.68, 0.85)***	0.82 (0.73, 0.92)***
Welsh, Australia	1.10 (0.93, 1.31)	1.12 (0.94, 1.33)	1.19 (1.00, 1.42)
Welsh, UK	0.82 (0.65, 1.04)	0.75 (0.60, 0.95)*	0.84 (0.66, 1.07)
Irish, Australia	0.95 (0.91, 0.99)*	0.96 (0.92, 1.01)	0.99 (0.95, 1.04)
Irish, Ireland	0.93 (0.76, 1.13)	0.87 (0.71, 1.06)	0.92 (0.75, 1.12)
Danish, Australia	0.90 (0.70, 1.15)	0.91 (0.71, 1.17)	0.94 (0.73, 1.21)
Danish, Denmark	0.43 (0.22, 0.84)*	0.36 (0.18, 0.71)**	0.38 (0.19, 0.77)**
French, Australia	1.04 (0.87, 1.24)	1.01 (0.84, 1.21)	0.99 (0.83, 1.19)
French, France	1.08 (0.73, 1.60)	0.87 (0.58, 1.29)	1.00 (0.67, 1.51)
Swiss, Australia	1.01 (0.62, 1.65)	1.00 (0.61, 1.63)	1.14 (0.69, 1.88)
Swiss, Switzerland	0.33 (0.17, 0.65)***	0.27 (0.14, 0.53)***	0.33 (0.17, 0.65)***
German, Australia	1.12 (1.05, 1.19)***	1.11 (1.04, 1.19)***	1.10 (1.02, 1.17)**
German, Germany	0.98 (0.86, 1.13)	0.82 (0.71, 0.94)**	0.87 (0.75, 1.00)*
Dutch, Australia	1.03 (0.88, 1.22)	1.02 (0.87, 1.20)	1.07 (0.90, 1.27)
Dutch, Netherlands	0.96 (0.85, 1.09)	0.88 (0.78, 1.01)	0.91 (0.80, 1.04)
Spanish, Australia	1.08 (0.77, 1.52)	1.08 (0.76, 1.52)	0.92 (0.64, 1.33)
Spanish, Spain	1.35 (0.87, 2.11)	1.14 (0.73, 1.79)	1.06 (0.67, 1.67)
Italian, Australia	1.05 (0.94, 1.18)	1.04 (0.93, 1.17)	1.07 (0.96, 1.21)
Italian, Italy	1.79 (1.59, 2.02)***	1.68 (1.49, 1.89)***	1.46 (1.29, 1.65)**
Greek, Australia	1.07 (0.88, 1.29)	1.08 (0.89, 1.30)	1.11 (0.91, 1.35)
Greek, Greece	2.04 (1.69, 2.46)***	1.81 (1.50, 2.19)***	1.33 (1.10, 1.62)**
Polish, Australia	1.17 (0.98, 1.40)	1.10 (0.92, 1.32)	1.15 (0.95, 1.39)
Polish, Poland	1.89 (1.51, 2.37)***	1.54 (1.22, 1.94)***	1.64 (1.30, 2.08)***
Maltese, Australia	1.26 (1.01, 1.57)*	1.27 (1.01, 1.59)*	1.11 (0.88, 1.41)
Maltese, Malta	1.71 (1.41, 2.09)***	1.59 (1.30, 1.94)***	1.19 (0.97, 1.46)
Lebanese, Australia	1.13 (0.85, 1.50)	1.22 (0.92, 1.62)	1.31 (0.98, 1.75)
Lebanese, Lebanon	3.97 (3.30, 4.76)***	3.67 (3.04, 4.42)***	2.11 (1.73, 2.57)***
Croatian, Australia	0.97 (0.63, 1.49)	0.94 (0.61, 1.46)	1.00 (0.64, 1.56)
Croatian, Croatia	2.70 (2.11, 3.46)***	2.30 (1.78, 2.96)***	1.84 (1.42, 2.39)***
Indian, Australia	1.86 (1.31, 2.63)***	1.88 (1.33, 2.68)***	1.64 (1.14, 2.35)**
Indian, India	1.13 (0.89, 1.43)	1.07 (0.84, 1.36)	1.43 (1.12, 1.83)**
Chinese, Australia	1.18 (0.94, 1.48)	1.16 (0.92, 1.45)	1.18 (0.93, 1.50)
Chinese, China	1.19 (1.05, 1.35)**	0.90 (0.79, 1.02)	1.05 (0.92, 1.20)
Number of occasions spent with friends or family			
Quartile 1 (Low)		1	1
Quartile 2 (Low to Moderate)		0.77 (0.74, 0.81)***	0.78 (0.75, 0.82)***
Quartile 3 (Moderate to High)		0.80 (0.77, 0.83)***	0.78 (0.75, 0.81)***
Quartile 4 (High)		1.00 (0.97, 1.04)	0.89 (0.85, 0.92)***
Number of telephone conversations			
Quartile 1 (Low)		1	1
Quartile 2 (Low to Moderate)		0.77 (0.74, 0.80)***	0.82 (0.79, 0.85)***
Quartile 3 (Moderate to High)		0.79 (0.76, 0.82)***	0.83 (0.80, 0.87)***
Quartile 4 (High)		0.78 (0.75, 0.81)***	0.85 (0.82, 0.88)***

Number of visits to social clubs		
Quartile 1 (Low)	1	1
Quartile 2 (Low to Moderate)	0.75 (0.72, 0.78)***	0.86 (0.83, 0.90)***
Quartile 3 (Moderate to High)	0.77 (0.74, 0.80)***	0.88 (0.84, 0.91)***
Quartile 4 (High)	0.95 (0.92, 0.98)**	1.01 (0.97, 1.04)
Number of people that can be relied on		
Quartile 1 (Low)	1	1
Quartile 2 (Low to Moderate)	0.58 (0.56, 0.61)***	0.66 (0.63, 0.68)***
Quartile 3 (Moderate to High)	0.48 (0.47, 0.50)***	0.56 (0.54, 0.58)***
Quartile 4 (High)	0.36 (0.34, 0.38)***	0.44 (0.42, 0.46)***

* p < 0.05; ** p < 0.01; *** p < 0.001
Model 1: Multilevel logit regression, adjusted for age and gender
Model 2: Model 1 + social interactions
Model 3: Model 2 + other individual-level variables, neighbourhood affluence and geographical remoteness

Figure 2 illustrates the ethnic and country of birth group differences in own-group ethnic density. Regardless of whether participants were born in Australia or the UK, those identifying as Australian (32.6%) or English (35.1%) ethnicities lived in the most ethnically dense neighbourhoods. Compared to the Australians and the English, the clustering of other ethnic groups in NSW was much lower. The highest mean ethnic density for non-Australian and non-English groups was for the Chinese born in China at 14.9%, whereas the lowest was for Australian born Swiss at 0.1%. There was evidence of heterogeneity of mean ethnic density within some groups. For example, Italians born in Australia had a mean of ethnic density of 4.9% but Italian-born Italians had 7.7%. Similar patterns were observed for Greeks, the Chinese and the Lebanese.

<Figure 2 here>

For the next stage of analysis we investigated the level of association with own-group ethnic density. This necessitated stratification of the sample by ethnic and country of birth group to match each individual with the relevant ethnic density measure. For example, Chinese ethnic density was matched to Chinese individuals (irrespective of whether they were born in China or Australia). We conducted these analyses for all groups, but due to space constraints, we focus our report on groups that have a mean ethnic density of 2% or more: Australians, English, Scottish, Irish, German, Italian, Greek, Lebanese, and Chinese. Table 3 reports mostly weak and positive or null (i.e. p>0.05) correlations between own group ethnic density and each of the social interactions variables. The most consistent set of correlations were for the social interactions variable which indicated how many people could be relied on within a one-hour travel-time.

Table 3: Correlations between own group ethnic density and each of the social interactions variables, stratified by ethnic and country of birth group

Ethnic group, country of birth	How many times last week did you:			How many people outside your home, within one hour of travel, do you feel you can depend on
	Spend time with friends/family who do not live with you	*Talk to someone (friends, relatives or others)*	*Go to meetings of social clubs, religious groups or other groups you belong to*	
Australia, Australia	0.012**	-0.017***	-0.012**	0.008*
Australian, Not Australia	-0.010	-0.053*	0.005	-0.001
English, Australia	0.019***	0.001	0.013**	-0.001
English, UK	0.0156	-0.010	0.029**	0.006
Scottish, Australia	0.007	0.008	0.001	0.014*
Scottish, UK	0.036*	0.029	-0.007	0.031
Irish, Australia	0.005	0.009	-0.001	0.005
Irish, Ireland	-0.014	-0.012	0.019	-0.027
German, Australia	-0.002	-0.016	0.016	0.024*
German, Germany	-0.022	0.020	-0.004	0.057**
Italian, Australia	0.018	-0.028	-0.035*	0.049**
Italian, Italy	0.028	0.025	0.045	0.086**
Greek, Australia	0.066*	-0.032	-0.028	0.117**
Greek, Greece	0.012	-0.026	0.052	0.017
Lebanese, Australia	-0.033	0.047	0.055	0.273***
Lebanese, Lebanon	-0.029	0.009	-0.061	-0.031
Chinese, Australia	0.048	-0.015	0.008	-0.059
Chinese, China	0.036	0.033	0.082**	-0.007

* p < 0.05; ** p < 0.01; *** p < 0.001

Table 4 reports the results of these ethnic and county of birth group specific models. Model 1 fitted the association between psychological distress and own-group ethnic density, adjusted for age and gender. A 1% increase in own-group ethnic density appeared protective against psychological distress for the English born in UK, and Australian-born Scottish, Irish and Chinese. Unexpectedly, increasing ethnic density was associated with a higher risk of psychological distress among Australians born in Australia. This model was adjusted by the social interactions variables (Model 2), but the associations between ethnic density and psychological distress persisted. Further adjustment for other individual-level variables, local affluence and geographical remoteness (Model 3) had a more substantial attenuating influence on the ethnic density odds ratios and 95% confidence intervals, except that for the English born in the UK and the overseas-born Australians. We did not find any evidence of interactions between ethnic density and any other independent variables in our models. **Results from the imputed data set were similar to those from complete-case analysis.**

Table 4: Association between own-group ethnic density and psychological distress by ethnic group, adjusting for social interactions and other individual and neighbourhood characteristics: Odds Ratios (95% Confidence Intervals)

	Model 1	Model 2	Model 3

	OR (95% CI)		
Australian, Australia	1.011 (1.008, 1.014)***	1.010 (1.007, 1.014)***	1.000 (0.997, 1.004)
Australian, not Australia	0.974 (0.959, 0.988)***	0.976 (0.961, 0.991)**	0.973 (0.955, 0.991)**
English, Australia	1.000 (0.996, 1.003)	1.000 (0.996, 1.004)	0.998 (0.994, 1.002)
English, UK	0.992 (0.986, 0.999)*	0.993 (0.987, 1.000)*	0.992 (0.985, 0.999)*
Scottish, Australia	0.972 (0.945, 1.000)*	0.979 (0.951, 1.007)	0.986 (0.957, 1.015)
Scottish, UK	0.982 (0.913, 1.057)	0.991 (0.921, 1.067)	1.002 (0.929, 1.081)
Irish, Australia	0.977 (0.962, 0.992)**	0.980 (0.965, 0.995)**	0.998 (0.983, 1.014)
Irish, Ireland	0.940 (0.861, 1.026)	0.946 (0.863, 1.038)	0.965 (0.868, 1.073)
German, Australia	0.987 (0.949, 1.028)	0.994 (0.954, 1.036)	1.000 (0.959, 1.042)
German, Germany	0.999 (0.901, 1.107)	1.004 (0.905, 1.115)	1.002 (0.895, 1.121)
Italian, Australia	0.991 (0.973, 1.009)	0.994 (0.977, 1.012)	1.013 (0.992, 1.034)
Italian, Italy	0.998 (0.985, 1.011)	1.002 (0.989, 1.016)	1.003 (0.988, 1.017)
Greek, Australia	0.983 (0.943, 1.024)	0.994 (0.955, 1.035)	1.006 (0.963, 1.052)
Greek, Greece	1.009 (0.987, 1.032)	1.011 (0.989, 1.034)	1.005 (0.979, 1.032)
Lebanese, Australia	1.008 (0.954, 1.065)	1.038 (0.981, 1.099)	0.983 (0.913, 1.057)
Lebanese, Lebanon	1.025 (0.999, 1.051)	1.023 (0.995, 1.051)	1.012 (0.983, 1.042)
Chinese, Australia	0.897 (0.812, 0.990)*	0.861 (0.760, 0.975)*	0.884 (0.699, 1.116)
Chinese, China	1.003 (0.992, 1.014)	1.004 (0.993, 1.014)	0.999 (0.988, 1.011)

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Model 1: Adjusted for age and gender

Model 2: Model 1 + social interactions

Model 3: Model 2 + individual characteristics, neighbourhood affluence and geographical remoteness

DISCUSSION

This paper examined the relationship between ethnic density and psychological distress in one of the most ethnic diverse areas of Australia. We found substantive heterogeneity in the risk of psychological distress between and within ethnic groups. Ethnic differences in social interactions, individual and neighbourhood characteristics did not explain the ethnic differences in the risk of psychological distress. More social interactions were associated with a lower risk of psychological distress, especially the number of people study participants felt they could rely on. Increasing own-group ethnic density was associated more social interactions and less psychological distress for some ethnic groups, but not all. However, it was the characteristics of individuals and the neighbourhoods in which they lived, not the social interactions, which mostly explained the ethnic density effects on psychological distress. Only the English born in the UK and the overseas-born Australians appeared to benefit from ethnic density after controlling for all other characteristics.

Although there are many studies on ethnic density and mental health [4 6 10-18], only two others have tested whether this relationship is explained by social interactions. A UK study [10] found a lower risk of common mental disorders for the Irish and for the Bangladeshi groups they studied in more

ethnically dense neighbourhoods. This was not fully explained by measures of practical and emotional social support. Contrary to the ethnic density hypothesis, this study also reported significantly higher risk of common mental disorders among white British in ethnically dense neighbourhoods. A study in the US [11] also showed the benefits of living in a higher own-ethnic group density neighbourhoods for the emotional well-being of Black and Hispanic groups. Measures of personal and neighbourhood social support partially explained the relationship for Blacks but not among Hispanics. Therefore, despite using contrasting measures of mental health and social interactions for different ethnic groups in the UK, US and Australia, our findings are consistent wherein social interactions only played a weak role in explaining the ethnic density effect on mental health.

A particular strength of our study includes the large sample sizes for many different ethnic groups; more than has been possible to analyse in previous studies [4]. This allowed stratification by country of birth, which afforded new insights into the heterogeneity of mental health, social interactions and ethnic density within groups. It is noteworthy that levels of ethnic density varied considerably by country of birth within some ethnic groups (e.g. the Chinese), though not all (e.g. the English). Given the general supposition that higher levels of ethnic density are better for mental health, it could be argued that for many groups, levels of ethnic density do not achieve a sufficient concentration necessary for health promotion in this sample. This hypothesis is not convincing, however, when one considers that no association between ethnic density and psychological distress was found for the Chinese born in China, who reported a mean ethnic density of approximately 15% and a maximum of nearly 80%, but there was an association among the Chinese born in Australia, for whom the mean ethnic density was about 5% and a maximum of around 63%. Likewise, there appeared to be a benefit of ethnic density for the UK-born English, but not the English born in Australia, despite having very similar levels of own-group ethnic density. As such, it would appear that a more nuanced approach may be required in future, using other sources of administrative data and qualitative methods to examine what it is about ethnically dense neighbourhoods which promote better mental health in some ethnic groups, but not all.

Our measures of psychological distress and social interactions have been widely validated. The small geographical scale (CCD) used to construct ethnic density provided a more accurate description of local circumstances than previous work which has relied upon larger spatial scales, helping to identify small 'pockets' of ethnic density and affluence that would otherwise have been hidden [47]. The focus on small scale geography is an advantage, though our study shares a common limitation among others of this genre in the reliance upon administrative boundaries, which are unlikely to perfectly correlate with residents' perceptions of neighbourhood [48]. **Such perceptions may vary depending upon location, circumstances and individual characteristics; including ethnicity. Therefore, it would appear that future research may need to explore the ethnic density hypothesis with customised measures of neighbourhood scale.**

It is reasonable to expect that social support from the neighbourhood would be reflected in the four measures of social interactions used in the study, albeit imperfectly. Social clubs attended, for example, may be located in the neighbourhood and many of the people who can be relied on within one hour of travel may in fact live much closer. The limitation, however, is that the questions used in the 45 and Up Study did not ask participants to distinguish how many of these interactions occurred within versus outside the neighbourhood in which they lived. It would be useful for further

work, therefore, to examine indicators which specify neighbourhood parameters within the question. Another limitation was that the 45 and Up Study was sampled from the Medicare Australia database which mainly includes Australian citizens and migrants on permanent residency visas. Only some migrants on temporary visas are included on this scheme and this is likely to mean that some ethnic minorities were not represented in our study. Representativeness is also a concern for a dataset wherein the response rate was only 18%, although comparisons between the 45 and Up Study and a 'representative' dataset have helped to alleviate these concerns to some extent [27]. **However, the comparisons in the aforementioned study did find heterogeneity between psychological distress and English spoken at home, and did not have an explicit focus on ethnic differences. Although regression methods are robust to missing data assumptions, there is still the possibility of bias.** The 45 and Up Study asked participants about Aboriginal and Torres Strait Islander origin, though responses to this variable were not available for this investigation and are the focus of a follow-up study. Many studies have suggested that spatial variation in the experiences of racism could help to explain the ethnic density effect [14 16]. Although we had no measure of racism in our study, virtually all benefits of ethnic density were already explained by other individual characteristics. Finally, our study represents only people 45 years and older, so it cannot discount the possibility of different patterns for younger age groups.

CONCLUSION

Ethnic groups in New South Wales, Australia, experience substantively different risks of psychological distress. These differences also align by country of birth, though there is no consistent pattern. Increasing social interactions, particularly those which help people to develop relationships with others they can depend on in times of need, are beneficial for mental health regardless of ethnicity and country of birth. In comparison, the ethnic density of where people live was protective only for the UK-born English and the overseas-born Australians.

ACKNOWLEDGEMENTS, COMPETING INTERESTS & FUNDING

We thank all of the men and women who participated in the 45 and Up Study. The 45 and Up Study is managed by the Sax Institute in collaboration with major partner Cancer Council New South Wales; and partners the Heart Foundation (NSW Division); NSW Ministry of Health; *beyondblue: the national depression initiative*; Ageing, Disability and Home Care, NSW Family and Community Services; and the Australian Red Cross Blood Service. We acknowledge the use of 2006 census and boundary data provided by the Australian Bureau of Statistics. To preserve the anonymity of participants in The 45 and Up Study, some parameters of the Census Collector District (CCD) level data cannot be reported. This location-indexing data from the 45 and up Study is highly restricted access and will be made available only through SURE (https://www.sure.org.au/).

The authors have no competing interests.

No funding was sought for this study.

LIST OF FIGURES

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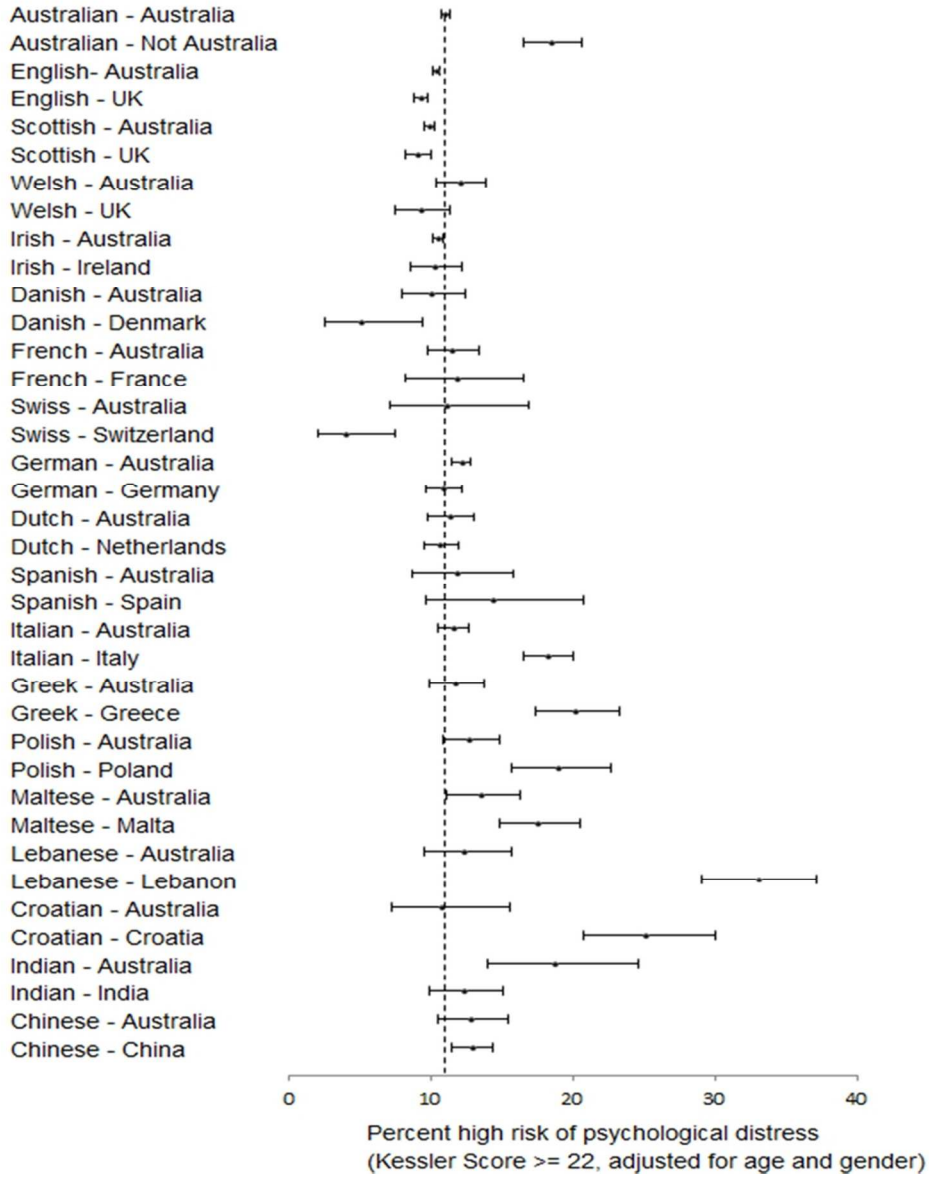
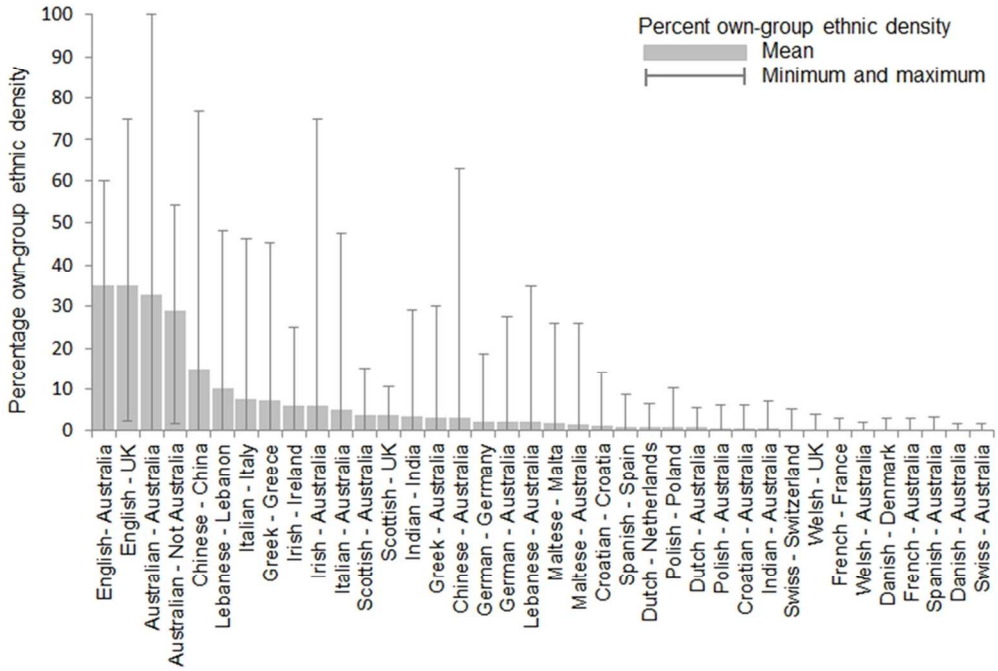


Ethnic and country of birth differences in the rate of psychological distress (Kessler scores of 22 and over), adjusted for age and gender
90x106mm (300 x 300 DPI)



Ethnic and country of birth differences in mean own-group ethnic density (percentage) at the Census Collection District (CCD) scale, with minimum and maximum: sorted highest to lowest
127x90mm (300 x 300 DPI)

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Author comment and page number
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	We have indicated in the title that this is a cross-sectional study. (see page 1)
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	We have provided a structured abstract in line with JECH recommendations. (see page 1)
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	We have explained the scientific background and rationale for the study in a two-paragraph introduction. (see page2)
Objectives	3	State specific objectives, including any prespecified hypotheses	We outline the objective of the study in the second paragraph of the introduction, see page2.
Methods			
Study design	4	Present key elements of study design early in the paper	The study design is outlined in the first paragraph of the methods section, see page 2.
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	The setting is outlined in the second paragraph of the introduction and the first paragraph of the methods section, see page 2.
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	Eligibility criteria and the selection of participant is discussed in paragraph 1 and 2

			of the method section, see page 2 and 3
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	All variables are discussed in paragraphs 2-8 of the method section, see page 2-4
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	The primary source of data is the 45 and Up Study and this outlined in the first paragraph of the method section, see page 2. Details of measurement are provided separately for the outcome variable (psychological distress), other individual variables and neighbourhood level measures, see page 3.
Bias	9	Describe any efforts to address potential sources of bias	Sources of bias were discussed in the paragraph headed 'statistical analysis', see page4. This focuses on adjustment for confounders and for the hierarchical data structure though the use of multilevel models.
Study size	10	Explain how the study size was arrived at	Study size has been explained in paragraph 1 and 2of the method section, see page 2&3
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	All variables have been outlined in the method section, see page 3 & 4 for details.
Statistical methods	12	(*a*) Describe all statistical methods, including those used to	All methods have

		control for confounding	been described in the section headed 'statistical analysis', see page 4. Explanation on how missing data were addressed in paragraph 2 of the method section, see page 3.
		(*b*) Describe any methods used to examine subgroups and interactions	
		(*c*) Explain how missing data were addressed	
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Sample selection was described in paragraph 2 of the method section, see page 2 & 3.
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Characteristics of the study participants including sample sizes and prevalence of key outcome and explanatory variables are reported in paragraph 1-4 of the result section, see page 4 & 5, figure 1&2 and table 1 & 2.
		(b) Indicate number of participants with missing data for each variable of interest	
Outcome data	15*	Report numbers of outcome events or summary measures	
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Sub-group analysis is reported in paragraph 5 & 6 in the result section, see page 5 and table 3.
Discussion			
Key results	18	Summarise key results with reference to study objectives	Key results are outlined briefly in paragraph 1 of the discussion section on page 6.
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and	Strengths and limitations of the

		magnitude of any potential bias	study are discussed in paragraph 3 of the discussion section, see page 6 &7.
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Interpretation of the findings within the context of the previous literature is reported in paragraph 2 of the discussion, see page 6.
Generalisability	21	Discuss the generalisability (external validity) of the study results	
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	No funding was sought for this study.

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.