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Differences by ethnicity in the association between unpaid caring and health trajectories over ten years in the UK Household Longitudinal Study

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Title: Differences by ethnicity in the association between unpaid caring and health

trajectories over ten years in the UK Household Longitudinal Study

Abstract

Background: Unpaid carers deliver critical social care. We aimed to examine

differences by ethnicity in [1] profiles of unpaid caring, and [2] associations between

caring and physical and mental health trajectories.

Methods: We used ten waves of data from 47,015 participants from the UK

Household Longitudinal Study (2009-2020). Our outcomes were SF-12 physical and

mental component scores. We performed bivariate comparison of profiles of caring

by ethnicity. We used multilevel linear mixed effects models to estimate associations

between caring and health trajectories and assess for heterogeneity by ethnicity.

Results: We found that caring profiles differed by ethnicity. The proportion caring for

someone within their household ranged from 39.7% of White carers to 70.1% of

Pakistani and 74.8% of Bangladeshi carers. The proportion providing 20+

hours/week of care ranged from 26.9% of White carers to 40.6% of Pakistani and

43.3% of African carers. Ethnicity moderated associations between caring and

physical but not mental health trajectories (test for interaction: p=0.038, p=0.75).

Carers showed worse physical health compared to non-carers among African (-1.93;

-3.52, -0.34), Bangladeshi (-2.01; -3.25, -0.78), Indian (-1.30; -2.33, -0.27), and

Pakistani carers (-1.16; -2.25, -0.08); Bangladeshi carers' trajectories converged with

non-carers over time (0.24; -0.02, 0.51). White carers showed better baseline

physical health than non-carers (0.35; 0.10, 0.60) followed by worsening trajectories

vs non-carers (-0.14; -0.18, -0.10).

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Conclusions: There are differences by ethnicity in profiles of caring and associations between caring and physical health trajectories. Future research should account for ethnicity to ensure applicability across groups.

Key messages:

What is already known on this topic:

- Unpaid carers provide the majority of care in the UK and caring has been shown to impact carers' health

- While some research has suggested differences in the prevalence and effect of caring by ethnicity in the UK, in-depth quantitative evidence is lacking

What this study adds:

- Exposure to caring—especially intensive caring—differs by ethnicity in the UK

- Ethnicity moderates the association between caregiving and physical health trajectories

How this study might affect research, practice or policy:

- The UK government should prioritise national policy to support carers as rising needs for unpaid caring may exacerbate inequities in the burden of unpaid caring in the UK

Ethics statement: Data collection for UKHLS is approved by The University of Essex Ethics Committee.

Competing interests statement: The authors declare no competing interests.

Introduction

Unpaid carers provide the majority of care in the UK, filling a critical role in the health and social service sectors. The work of unpaid carers (who take care of family or friends needing support due to illness, disability, or old age) has been valued at £132 billion per year and rising.[1] Roughly 5 million people in England and Wales are unpaid carers, with 1.5 million caring >50 hours per week.[2] The need for unpaid carers is projected to rise by 63% from 2015 to 2035.[3]

Evidence suggests caring impacts the health of carers; carers show worse self-reported health,[4] higher cholesterol,[5] and higher adiposity in women.[6] Women providing long-term or intermittent care show slightly elevated psychological distress vs non-carers from initiation of care,[7] and carers show increased psychological distress at transition to caring, especially caring more than 20 hours per week or for someone in the household.[8] On the other hand, some research found elderly female carers had a lower risk of mortality than non-carers, suggesting a "healthy carer" hypothesis of healthier people being more able to take on caring.[9]

Heterogeneity in caring by ethnicity

Evidence has suggested heterogeneity in the prevalence and effect of caring by ethnicity.[10–12] Structural racism and the social construction of ethnicity are tied to unequal hierarchical social positions by race/ethnicity, producing inequities in the distribution of fundamental causes of health i.e. access to flexible resources and social determinants of health.[13,14] Research has also highlighted differential effects of these resources as social factors such as structural racism diminish the potential for minoritized individuals to leverage flexible resources (leading to 'diminished

returns').[15–18] Inequities by ethnicity in access to—and ability to benefit from—flexible resources and social determinants of health may influence not only the health of carers and care recipients, but also likelihood of providing unpaid care and intensity of exposure to caring.[19]

Evidence on caring by ethnicity in the UK is limited. The 2021 census in England and Wales shows differences in the age-standardized prevalence of unpaid caring by ethnicity, ranging from roughly 6% (among African individuals) to 10% (among White British individuals).[20] Research has found ethnic minority carers more likely to care for someone with mental health problems, more young adult carers in Indian, Pakistani, and Bangladeshi groups,[11] and higher depression among South-Asian than White British carers, although these all used cross-sectional data.[10] 2014 research found higher anxiety and depression among British Indian than White British carers, although this was based on small samples.[12] Caring charity and advocacy organisations highlight that ethnic minority carers are underrepresented not only in research on caring impacts, but also intervention evaluation.[21] We hope to contribute to the representation of diverse experiences and the impact of caring by ethnicity.

To understand potential health disparities by ethnicity, it is important to consider not only effect modification but also potential differences in prevalence and intensity of exposure.[22] We therefore sought to examine potential differences in both caring profiles as well as associations between caring and health in the UK. Objective 1: Examine whether caring status and care characteristics differ by ethnicity. Objective

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2: Examine whether associations between caring and SF-12 mental and physical health trajectories differ by ethnicity.

Materials and methods

<u>Study population</u>

We used the UK Household Longitudinal Study (UKHLS), a nationally representative longitudinal study of roughly 40,000 households with participants interviewed roughly annually.[23] More details are in the supplement and reported elsewhere.[24] In wave 1 (W1), the sample was supplemented by an ethnic minority boost of over 4,000 households. Our analysis includes data from W1 (fielded Dec 2008-Mar 2011) to 10 (fielded Dec 2017-May 2020).

All participants aged 16+ in W1 were eligible for inclusion. We excluded those caring for clients of voluntary organisation given our focus was the role of informal unpaid caring outside of any formal caring arrangement that could include volunteer organisations (detail in supplement). We excluded those missing W1 exposure, outcome, or covariates (Figure 1). Final sample was 47,015 (92.2% of initial sample); eTable 1 shows contributing sample size for each wave.

<u>Outcomes</u>

The 12-item Short Form Health Survey (SF-12) is a standard measure of self-reported health, measured every wave in UKHLS, providing a Physical (PCS) and Mental (MCS) Component Summary Scale Score, where higher scores represent better health (detail in supplement).[25]

Exposure

Caring status was measured each wave using two questions: *"Is there anyone living with you who is sick, disabled or elderly whom you look after or give special help to (for example, a sick, disabled or elderly relative, husband, wife or friend etc)?"* and *"Do you provide some regular service or help for any sick, disabled or elderly person not living with you?"*. Participants were coded as carers if they responded 'Yes' to either question. Our main exposure was defined as W1 caring status.

Four additional care characteristics were included: hours per week, residence of recipient(s), number of recipient(s), and relationship to recipient(s) (detail in supplement). We were unable to account for care recipient condition or age of recipient.

Covariates

UKHLS includes self-identification of ethnicity using the 2011 census question.[24] The ethnic minority boost sample aimed to provide ≥1,000 adult participants in five groups: African, Bangladeshi, Caribbean, Indian, and Pakistani.[24] We created the following categories: African, Bangladeshi, Caribbean, Indian, Pakistani, White British, and Other. We reported results by ethnicity in alphabetical order. (Detail in supplement).

We adjusted for the following potential confounders using W1 data to avoid adjusting for post-exposure variables: Age, Sex, Marital status, Number of own children in the household, Highest educational attainment, Employment status, Occupational class, Net monthly equivalised household income, and baseline Limiting longstanding

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illness (LLI) (excluded from models with physical health outcome) (detail in

supplement). In models stratified by ethnicity, we additionally controlled for nativity

(whether an individual was born inside or outside the UK) based on existing

evidence regarding the intersecting roles of socially constructed ethnicity and

nativity.[26]

Statistical methods

Statistical analyses were performed in Stata 17. To assess potential bias from

missing data, we compared our analytical sample to sample excluded for

missingness. We used chi-squared tests for bivariate associations between baseline

participant characteristics and caring. We included UKHLS survey weights at

baseline to correct for unequal selection probability and non-response (detail in

supplement).

In Objective 1, we examined differences in caring profiles at W1 (2009-2011) by

ethnicity. We used chi-squared tests for bivariate associations between ethnicity and

the four baseline care characteristics described above.

In Objective 2, we examined whether there were differences in the association

between W1 caring and SF-12 trajectories from W1 to 10 (2009-2020). We

estimated the association between caring and health trajectories using multi-level

linear regression (growth curve models) to account for correlation between repeated

measures within an individual ('mixed' package in Stata). Models included wave,

wave-squared, interaction between W1 caring and wave, and random slope for wave

and wave-squared. All included a quadratic wave term given improved model fit. We

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graphed health trajectories based on estimated average marginal effects (detail in supplement). Model 1 adjusted for baseline age and sex, and Model 2 additionally adjusted for remaining covariates.

We assessed effect modification by ethnicity via a triple interaction term between ethnicity, W1 caring, and wave. Where we found evidence for differences, we stratified by ethnicity. Our main results present the stratified adjusted model. Given some of the proposed confounders may actually serve as mediators (e.g. education, employment, occupational class, income) for the effect modification by ethnicity, we also conducted stratified analysis without adjusting for these factors in the supplement. Comparing these results is valuable; while the adjusted model may block some of the effect modifier's pathway, the crude model may leave the main exposure confounded. The true estimate may be hypothesised to lie between these estimates. Reassuringly, the results from the two specifications were very similar.

Results

Sample characteristics

Table 1 summarises sample characteristics at baseline. 16.4% were carers. Distribution of ethnic groups was: 1.3% African, 0.5% Bangladeshi, 0.9% Caribbean, 2.3% Indian, 1.1% Pakistani, and 86.5% White. Carers were more likely to be Bangladeshi, White, and Pakistani (difference between Bangladeshi and Pakistani not visible due to rounding). Carers had higher mean age, were more likely to be female, married, have LLI, and be retired or looking after the home/ family. They were less likely to have a degree, be employed, or in management/ professional occupational class, and had lower household income.

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eTable 2 compares the analytical sample with cases excluded due to missingness. The included sample were slightly more likely to be carers, White, female, age 50+, separated/ divorced, have children, higher education, LLI, not be employed, be in the lowest income tertile, and have lower mean SF-12 PCS. However, our final sample included 92.2% of our initial eligible sample, and potential bias due to complete case analysis has been found to be relatively low in analyses with missingness <10% and large sample sizes.[27]

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Table 1. Sample characteristics by caring status at wave 1

	Carer (n=7,798)	Not carer (n=39,217)	Total (n=47,015)		p-value for % diff
	% / Mean(SE)	% / Mean(SE)	% / Mean(SE)	N*	
Ethnicity					<0.001
African	0.4%	1.4%	1.3%	1,391	
Bangladeshi	0.5%	0.5%	0.5%	1,104	
Caribbean	0.8%	0.9%	0.9%	1,109	
Indian	1.7%	2.4%	2.3%	1,868	
Pakistani	1.1%	1.1%	1.1%	1,407	
White	91.1%	85.6%	86.5%	35,484	
Other	4.3%	8.0%	7.4%	4,652	
Age (years)					
	50.81(0.26)	45.60(0.15)	46.45(0.14)	47,015	<0.001
Sex					<0.001
Male	42.8%	50.0%	48.8%	20,699	
Female	57.2%	50.0%	51.2%	26,316	
Marital status					<0.001
Married/ civil partner	60.5%	47.4%	49.6%	23,871	
Living as couple	10.1%	12.9%	12.4%	5,324	
Widowed	3.9%	7.3%	6.7%	2,832	
Separated/ divorced	8.3%	7.5%	7.6%	4,178	
Never married	17.3%	24.9%	23.6%	10,810	
# own children <16 in household					<0.001
0	74.8%	72.8%	73.1%	33,044	
1	11.9%	12.5%	12.4%	6,188	
2	8.7%	10.7%	10.3%	5,283	
3+	4.6%	4.1%	4.2%	2,500	
Highest qualification					<0.001
Degree	16.6%	21.7%	20.8%	10,172	
Other higher education	12.3%	11.0%	11.2%	5,256	
A-level/ equivalent	18.8%	19.9%	19.7%	8,824	
GCSE/ equivalent	21.8%	20.8%	21.0%	9,691	
Other qualification	13.4%	10.0%	10.5%	4,866	
No qualification	17.0%	16.6%	16.7%	8,206	
LLI					<0.001
No	69.0%	76.4%	75.2%	35,460	
Yes	31.0%	23.6%	24.8%	11,555	
Employment status					<0.001
Employed	50.9%	56.7%	55.8%	25,143	
Unemployed	6.5%	5.9%	6.0%	3,146	
Retired	26.0%	21.1%	21.9%	9,642	
Family/ home care	8.9%	4.8%	5.5%	3,501	
Student/ training	3.1%	7.5%	6.8%	3,463	
LT sick/ disabled	3.4%	3.4%	3.4%	1,789	
Other	1.2%	0.6%	0.7%	331	
Occupational class					<0.001
Management/ professional	19.7%	24.0%	23.3%	10,535	
Intermediate	13.2%	13.7%	13.6%	6,137	
Routine	19.1%	21.2%	20.8%	9,300	
Not employed	48.1%	41.2%	42.3%	21,043	
Net equivalized monthly household income (£)					
	1481.26(15.70)	1522.41(9.45)	1515.65(8.68)	47,015	0.015

Source: UK Household Longitudinal Study, wave 1.

*Sample size unweighted, percentage weighted

Abbreviations: Standard Error (SE), Sample size (N), Limiting longstanding illness (LLI), General Certificate of Secondary Education (GCSE)

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<u>Objective 1: Caring characteristics by ethnicity</u>

The proportion of carers by ethnicity was: Bangladeshi (17.6%), White (17.3%),

Pakistani (16.4%), Caribbean (15.6%), Indian (11.8%), African (5.6%) (eTable 3).

Table 2 shows care characteristics by ethnicity. Bangladeshi (74.8%) and Pakistani

(70.1%) carers were most likely to be co-resident caring (inside the home), while

White carers were least likely (39.7%). Pakistani carers were most likely to be caring

for 2+ care recipients (22.9%), while African carers were least likely (14.1%). African

(43.3%) and Pakistani (40.6%) carers were most likely to be caring for 20+ hours per

week, while White carers were least likely (26.9%). Caring for a child was most

prevalent in African (23.8%), Bangladeshi (14.2%), and Caribbean (19.2%) carers.

Caring for a parent was most prevalent in Indian (54.7%) and Pakistani (57.0%) and

least prevalent in African (24.1%) carers. Caring for a partner was most prevalent

among African (19.1%) and White (20.9%) carers.

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Table 2. Care characteristics by ethnicity among carers at wave 1

	African (n=80) % / Mean(SE)	Bangladeshi (n=194) % / Mean(SE)	Caribbean (n=174) % / Mean(SE)	Indian (n=230) % / Mean(SE)	Pakistani (n=250) % / Mean(SE)	White (n=6,383) % / Mean(SE)	Other (n=487) % / Mean(SE)	Total (n=7,798) % / Mean(SE)	N*	p-value for % diff
Location of recipient(s)										<0.001
In home only	56.2%	70.2%	45.7%	56.7%	59.9%	34.5%	41.0%	35.9%	2,832	
Outside home only	41.7%	25.2%	48.9%	39.9%	29.9%	60.2%	54.6%	59.0%	4,555	
Both	2.1%	4.6%	5.5%	3.3%	10.2%	5.2%	4.4%	5.2%	411	
# recipients										0.66
1	85.9%	84.0%	83.2%	81.9%	77.1%	79.5%	81.1%	79.7%	6,216	
2+	14.1%	16.0%	16.8%	18.1%	22.9%	20.5%	18.9%	20.3%	1,582	
Hours/ week caring										0.002
0-4	15.3%	29.1%	34.7%	35.3%	18.9%	37.6%	36.6%	37.1%	2,766	
5-9	20.5%	13.2%	16.2%	13.2%	16.7%	18.5%	16.3%	18.2%	1,418	
10-19	15.2%	16.0%	10.6%	10.4%	19.2%	12.0%	12.4%	12.1%	989	
20+	43.3%	36.0%	34.1%	35.1%	40.6%	26.9%	29.3%	27.5%	2,252	
Other	5.7%	5.7%	4.5%	5.9%	4.5%	5.0%	5.5%	5.1%	373	
Relationship to recipient (% Yes)										
Child	23.8%	14.2%	19.2%	9.3%	9.9%	9.3%	12.2%	9.6%	805	0.002
Parent	24.1%	47.6%	43.8%	54.7%	57.0%	46.5%	41.8%	46.4%	3,623	0.001
Partner	19.1%	16.2%	12.0%	14.0%	17.9%	20.9%	18.6%	20.6%	1,586	0.048
Other	37.4%	28.1%	31.4%	27.5%	23.4%	31.1%	35.0%	31.1%	2,392	0.21

Source: UK Household Longitudinal Study, wave 1.

*Sample size unweighted, percentage weighted

Abbreviations: Standard Error (SE), Sample size (N)

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<u>Objective 2: Caring and physical and mental health trajectories by ethnicity</u>

We found evidence for an overall association between caring and mental health trajectories, with carers showing worse mental health at baseline (change in SF-12: -1.11; 95%CI: -1.33, -0.90) but mental health trajectories of carers converged with those of non-carers over time (0.09; 0.06, 0.13) (Figure 2, eTable 4). However, we did not find evidence of heterogeneity in this association by ethnicity based on the interaction term for caring, ethnicity, and wave (eTable 5; test for interaction: p=0.75).

We found evidence for an association between caring and physical health trajectories, with carers showing better physical health at baseline (0.21; -0.03, 0.45) followed by a physical health trajectory that worsened more rapidly over time than for non-carers (-0.13; -0.17, -0.10) (Figure 2, eTable 4). We found evidence of heterogeneity in this association by ethnicity based on the interaction term for caring, ethnicity, and wave (eTable 5; test for interaction p=0.038). Figure 3 shows conditional growth curves stratified by ethnicity. (Detailed results: eTable 6, Growth curves for the crude model: eFigure 1). These results should be interpreted cautiously given wide and overlapping confidence intervals.

Among Bangladeshi individuals, caring was associated with slightly worse baseline physical health (-2.01; -3.25, -0.78), and carers physical health trajectories converged with non-carers over time (0.24; -0.02, 0.51). Among three of the ethnic groups we found slightly worse baseline physical health followed by similar physical health trajectories over time among carers vs non-carers. These were: African (baseline: -1.93; -3.52, -0.34; change each wave: 0.16; -0.22, 0.55), Indian (baseline:

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-1.30; -2.33, -0.27, change each wave: 0.05; -0.15, 0.24), and Pakistani (baseline: -1.16; -2.25, -0.08, change each wave: -0.06; -0.27, 0.15). Among White individuals, caring was associated with slightly better baseline physical health (0.35; 0.10, 0.60), followed by a physical health trajectory that worsened more rapidly over time than for non-carers (-0.14; -0.18, -0.10). Among Caribbean individuals, we did not find strong evidence for a difference in baseline physical health (-0.43; -1.86, 0.99), or differences in physical health changes each wave between carers and non-carers (0.20; -0.47, 0.07). However, confidence intervals are wide and overlapping. Some stratified graphs show upward trend in physical health at later waves, possibly due to attrition of individuals with lower physical health.

Discussion

We found that profiles of caring and intensity of caring differed by ethnicity. Caring prevalence was relatively high among Bangladeshi, White, and Pakistani ethnic groups. Co-resident caring was most prevalent among Bangladeshi and Pakistani carers, caring for 2+ recipients was most prevalent among Pakistani carers, and caring 20+ hours per week was most prevalent among Pakistani and African carers. Exposure to more intense caring may influence how caring impacts physical health over time.

We also found heterogeneity by ethnicity in associations between caring and physical but not mental health trajectories. Although in pooled analysis carers showed better baseline physical health than non-carers, in stratified analysis this association was only evidenced in the White ethnic group, and carers showed worse baseline physical health than non-carers in the African, Bangladeshi, Indian, and

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Pakistani ethnic groups. Although in pooled analysis carers showed a greater decline in physical health compared to non-carers, in stratified analysis this was only evidenced in the White ethnic group, and we saw the opposite effect among Bangladeshi carers vs non-carers.

While our research did not examine potential pathways for the observed heterogeneity in profiles of caring, existing research notes some potential pathways. The demographic make-up of ethnic groups in the UK have been differentially shaped by historical colonialism and immigration policies, leading to differences in migration histories, age profiles, health, and family patterns by ethnicity,[28] which may influence profiles of caring (e.g. relationship to care recipient or intensity of care). In qualitative research, South Asian and Black Caribbean unpaid carers reported greater familial expectation of caring,[29] which may influence intensity of caring (e.g. co-resident care or hours per week). Ethnic minority carers are more likely to face barriers to accessing caring services,[10,11] language barriers,[30] and lower financial ability to hire caring support if needed, linked to the historical and contemporary effects of structural racism.[11] In our research we found higher exposure to intense caring among Bangladeshi and Pakistani carers, which could be linked to the factors discussed above.

In addition, community-based organisations have highlighted other ways structural racism has contributed to potential inequities, as ethnic minority carers face higher risk of marginalisation from health and welfare systems, and are more likely to face poverty, unemployment, area deprivation, social exclusion, and institutional racism.[31] Beyond differential intensity of exposure to caring, these factors could separately

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influence the physical health impact of providing care by influencing the burden placed on unpaid carers and whether individuals in poor physical health themselves still take on care. However, more research into potential mechanisms for differential associations between caring and physical health is needed.

In contrast with some (limited) UK cross-sectional research,[10,12] we did not find evidence that ethnicity moderated associations between caring and mental health. There are a few reasons our research may differ: prior research compared carers' mental health across ethnic groups (rather than comparing whether associations between caring and mental health differed by ethnicity) which is likely to be influenced by existing differences in mental health across ethnic groups that may not be related to caring. Also, we used a population-based (rather than purposive) sample.

There are a few possible interpretations of differences in baseline physical health by ethnicity. This could represent a selection effect of who takes on caring, with White individuals in poor physical health less likely to take on caring than Bangladeshi and Indian individuals in poor health. Alternatively, this could represent either the immediate impact of initiation of care (if W1 carers on average initiated care recently), or the long-term impact of caring (if they have been caring for extended period).

Our research addresses a gap in research on caring by ethnicity using population-based data. UKHLS is a large, nationally representative, longitudinal dataset with detailed data on caring and health status and covariates among both carers and

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non-carers. We were able to use growth curve modelling, accounting for correlation

between repeated measures within individuals. UKHLS' ethnic minority boost sample

allowed us to avoid combining ethnic groups for five boosted groups often previously

combined.

There are several limitations. We lack access to caring trajectories prior to W1 so are

unable to differentiate between new and ongoing carers and may face residual

confounding due to prior caring trajectories. We were unable to accommodate

changes in exposure over time; after W1, carers may have maintained, discontinued,

or intermittently provided care, which could influence the impact of caring.[7,8]

Nonetheless, our approach provides valuable insight on health trajectories after

caring at a single time-point, akin to a target trial framework examining an

intervention irrespective of subsequent exposure. Alternatively, if our exposure of

interest were the impact of long-term exposure to caring, our approach would

represent intention-to-treat analysis with caring changes after W1 representing

misclassification from the W1 definition; this would tend to influence results towards

the null under a true effect.[32] Additionally, there may be differential misclassification

of exposure by ethnicity; research highlights ethnic minority carers are less likely to

self-identify as carers.[21] We were unable to explore the full nuance of ethnicity or

intersectional identities. Although we separately analysed the boosted groups, we

faced small cell sizes and limited power in stratified analysis and other groups could

not be individually examined. We were unable to analyse other dimensions of care

(carer age, relationship to recipient, recipient condition). There is potential for bias

due to missing data, especially due to attrition.

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Conclusions

This research contributes evidence of heterogeneity by ethnicity in profiles of caring and in the association between caring and physical but not mental health trajectories in the UK. We found that pooled associations between caring and physical health are reflected only in the White ethnic group, suggesting evidence that does not account for ethnicity may fail to represent experiences of carers outside the White ethnic group. Our findings highlight the importance of avoiding grouping heterogeneous ethnic groups given noteworthy differences in previously combined subgroups. Finally, this research supports the importance of national policy to support carers, as growing need for unpaid caring[3] could exacerbate existing inequities in the distribution of unpaid caring across society.

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Eligible sample:
Participants age 16+ present in UKHLS W1
n=50,994

Exclude participants reporting formal caring for voluntary organisation:
n=104

Eligible non-excluded sample:
n=50,890

Exclude missing observations on independent variables:

Caring characteristics:
Caring status, n=11
recipients, n=10
Hours/ week, n=13
Residence of recipient, n=0
Relationship to recipient, n=0

Main covariates:
Ethnicity, n=3
Age, n=0
Sex, n=1
Marital status, n=19
Children in household, n=0
Educational attainment, n=14
LLI, n=30
Employment status, n=4
Occupational class, n=151
Household income, n=31

Exclude participants missing outcome (SF-12):
n=3,594

Eligible included sample with SF-12 outcome:
n=47,296

Eligible included sample with no missing data at baseline:
n=47,015

Figure 1. Flow diagram of study sample inclusion

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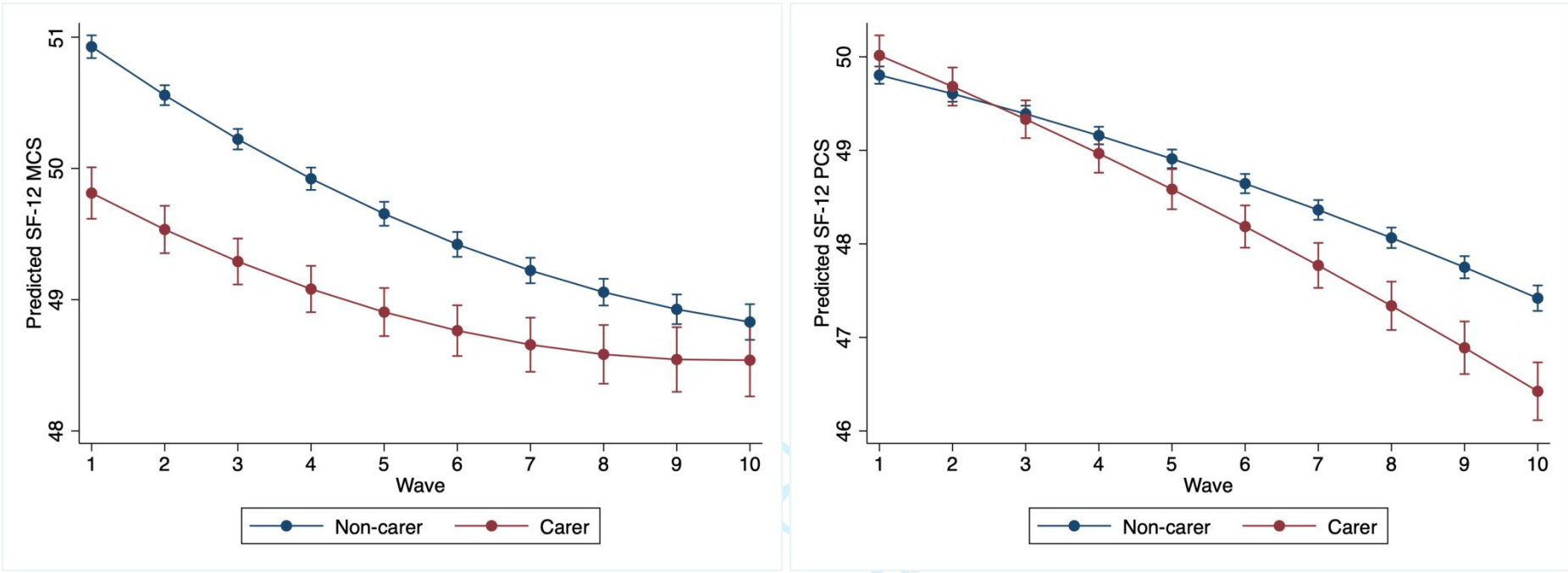
Figure 2. Predicted SF-12 MCS (panel A) and SF-12 PCS (panel B) Waves 1-10
Source: UK Household Longitudinal Study, Waves 1-10.
Weighted using survey weight at baseline.
Model adjusted for baseline age, sex, marital status, # own children under 16 in household, highest educational qualification, LLI (for MCS), employment status, occupational class, net equivalized monthly household income. Model includes linear and quadratic term for wave.

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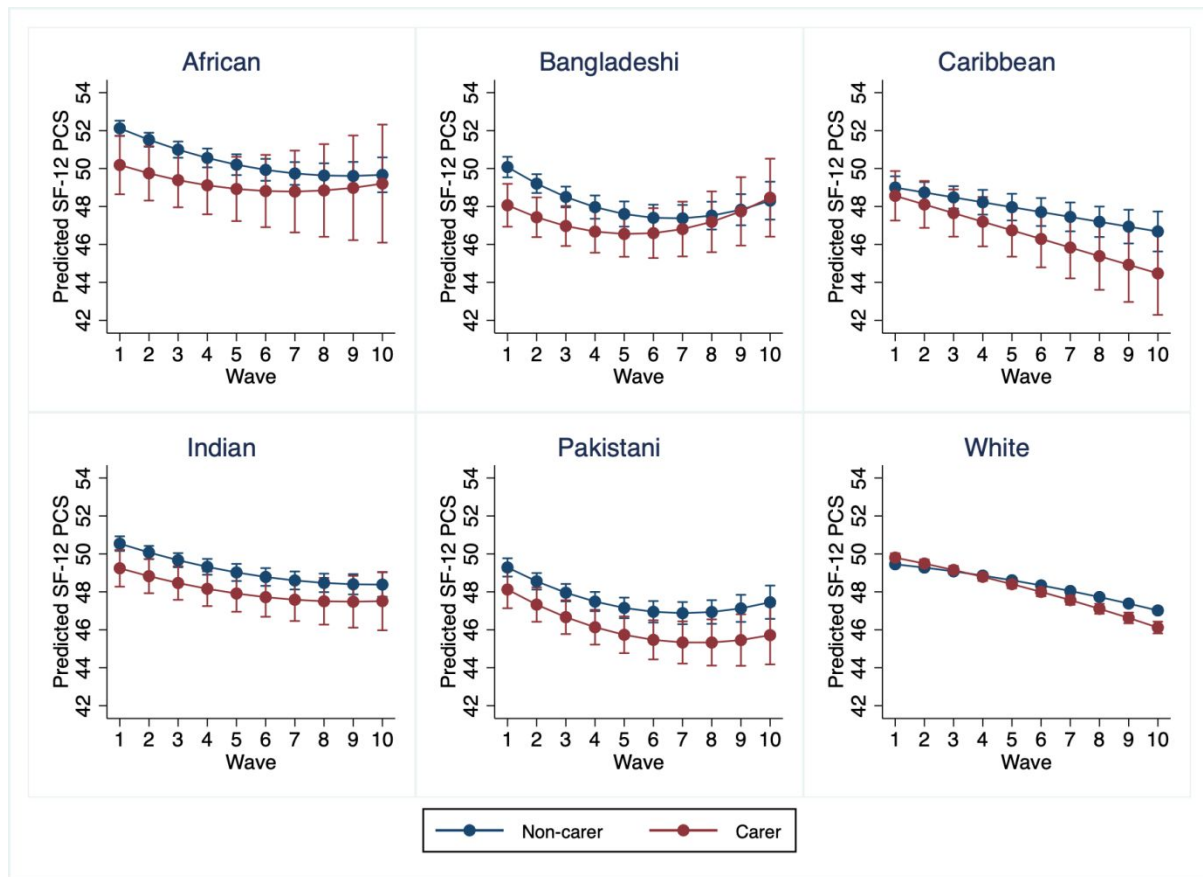
Figure 3. Predicted SF-12 PCS Waves 1-10 for UKHLS adults by ethnicity
Source: UK Household Longitudinal Study, waves 1-10. Model adjusted for baseline age, sex, marital status, # own children under 16 in household, highest educational qualification, employment status, occupational class, net equivalized monthly household income, and nativity. Model includes linear and quadratic term for wave.

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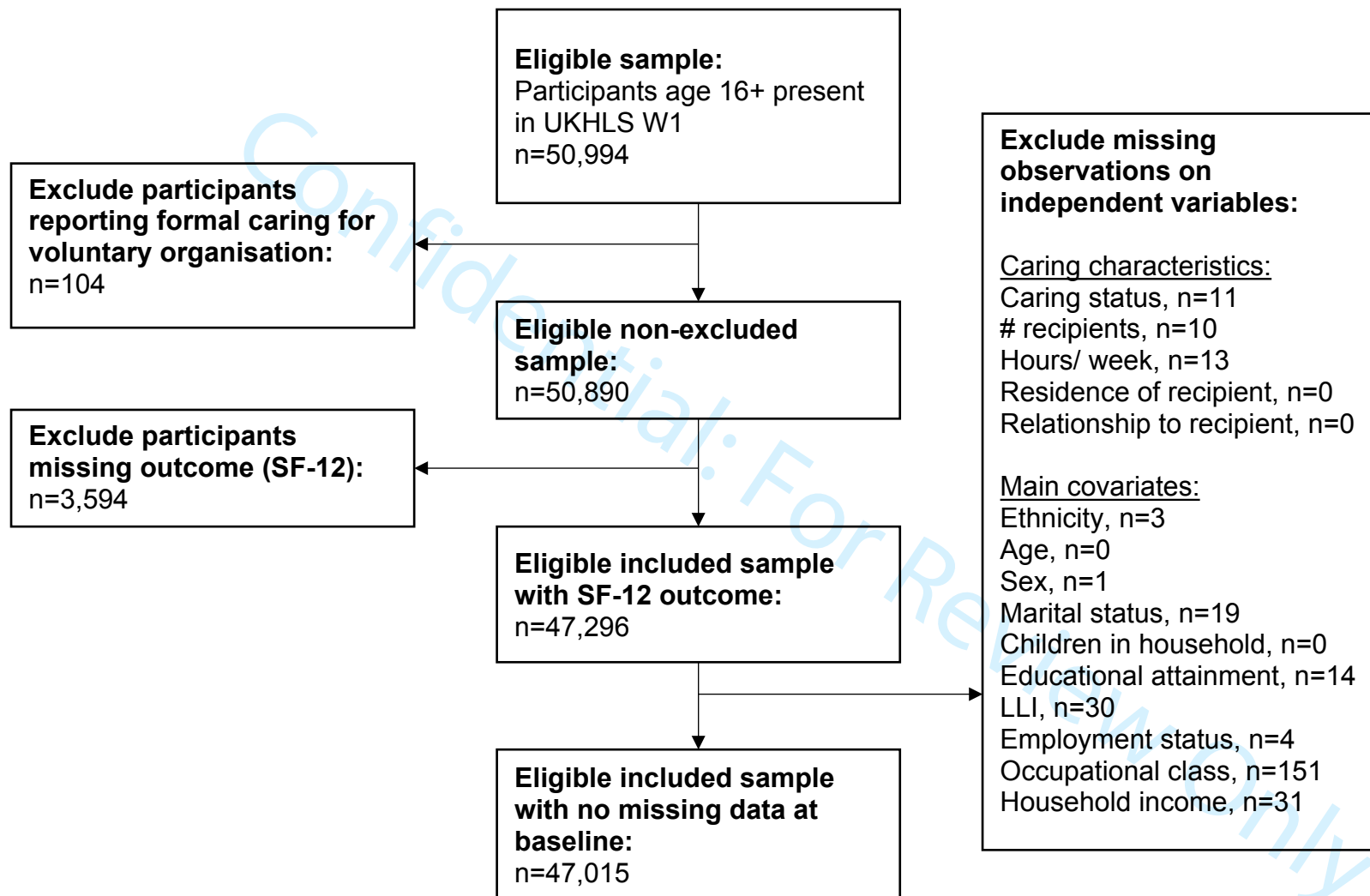41
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Online Supplemental Materials

Methods

We followed Strengthening the Reporting of Observational Studies in Epidemiology

(STROBE) guidelines for cohort studies.[1]

Study population

UKHLS covers a range of subjects, including health, work, family, and social life. The

main questionnaire is completed by everyone in the household aged 16+ face-to-

face or online. UKHLS data are accessible via UK Data Service. We excluded data

from wave 11 onward due to the impact of the Covid-19 pandemic on our outcomes

of interest and on UKHLS fieldwork. Fieldwork for each wave of UKHLS spans a 24-

month period that overlaps with previous and/or subsequent waves (i.e. Wave 1

fieldwork was conducted Dec 2008 – Mar 2011, Wave 2 fieldwork was conducted

Jan 2010 – Mar 2012); individual participants are interviewed approximately

annually.

The relationship to care recipient(s) was captured via the following question *"Who is

the person that you look after or help?"* The options were "Parent/parent-in-law,"

"Grandparent," "Aunt/uncle," "Other relative," "Friend or neighbour," "Client(s) of

voluntary organisation," and "Other." Anyone selecting "Client(s) of voluntary

organisation" was excluded from our sample.

UKHLS' ethnic minority boost was performed via sampling postal sectors with high

proportions of ethnic minority groups based on the 2001 census.[2] Invited households

were asked a screening question used to select final included participants:[3] *"Does*

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anyone living at this address come from or have parents or grandparents from any of the following ethnic groups?"

Outcomes

The SF-36 is extensively validated as a reliable measure across populations,[4] and was adapted to SF-12 for participant ease while maintaining accuracy including for longitudinal research.[5] PCS-12 components relate to physical functioning (limitations in moderate activities/ climbing stairs), physical role limitations (accomplishing less than you would like/ limitations in activities you can do), bodily pain (interfering with normal work), and general health (excellent to poor). MCS-12 components relate to mental health functioning - vitality (energy level), social functioning (health interfering with social activities), emotional role limitations (accomplishing less than you would like/ unable to do activities as carefully), and mental health (feeling calm/ peaceful or downhearted/ blue).[6]

Care characteristics

Residence of recipient (inside or outside household or both) was determined based on the caring questions above. For number of recipients, we calculated a sum of recipients inside and outside household. Weekly hours caring was asked on categorical scale from 0-4 hours to 100+ hours per week/ continuous care. Based on small cell sizes, we combined upper categories (20-34, 35-49, 50-99, 100+ hours) into '20+ hours per week' category. Carers reporting caring inside household were asked which members they cared for, which we used to determine relationship to recipients. For recipients outside household, relationship was asked for the first two. Based on existing literature, three key relationships were considered especially

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important: caring for parent, partner, and child. We created three binary variables

(given potential for multiple recipients with different relationships) capturing whether

participant cared for parent (Y/N), partner (Y/N), child (Y/N), or other (Y/N).

Ethnicity

Ethnicity is captured via the question *"What is your ethnic group?"*, offering single

selection among 17 ethnic groups. While we combined several smaller groups into

the 'Other' category, we were able to keep the five from the ethnic minority boost

separate. The following groups were combined into 'Other:' 'Arab', 'Chinese', 'Gypsy

or Irish Traveller', 'Irish', 'Any other Asian background', 'Any other Black

background', 'Any other White background', 'White and Asian', 'White and Black

African', 'White and Black Caribbean', 'Any other mixed background', and, 'Any other

ethnic group'.

Potential confounders

Age, Sex (Male or Female), Marital status (Single/ never married, Married/ civil

partnership, Living as a couple, Separated/ divorced, Widowed), Number of children

(number of own children in the household under the age of 16 including natural

children, adopted children and step children), Highest educational attainment (No

qualification, GCSE or equivalent secondary school qualification, A-level or

equivalent tertiary school qualification, Other higher education, Degree qualification,

or Other qualification), Employment status (Employed (self-employed, paid

employment, maternity leave), Unemployed, Retired, Providing family/ home care,

Student/ training (full-time student, government training scheme, on apprenticeship),

Long-term sick/ disabled, Other (unpaid family business, doing something else)),

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Occupational class (National Statistics Socio-Economic Classification (NS-SEC) 3-

class version: Management/ professional, Intermediate, Routine, or Not employed),

Net monthly equivalised household income (calculated using monthly household

income divided by OECD-modified equivalence scale for each household), and

baseline Limiting longstanding illness (LLI) (following the approach in existing

literature,[7] participants with long-standing illness with difficulties on a limiting area

were coded as having LLI; participants without long-standing illness or with long-

standing illness but no limiting areas were coded as having no LLI). Two covariates

were continuous (age and household income); they were used in continuous form in

regression models.

Statistical analysis

Following recommendations in growth curve literature, we applied maximum

likelihood estimation, which minimises impact of missing data across waves by using

all participants with non-missing outcome in a given wave.[8,9] We included random

intercept and random slope to account for the fact that health trajectories may differ

at baseline and in rate of change. We used unstructured covariance to allow

intercept and slope of health trajectories to correlate. We allowed conditional growth

curves by including an interaction term between W1 caring and wave given intercept

and slope may vary by W1 caring. We used likelihood ratio tests to assess inclusion

of random slopes, addition of quadratic term for wave, and interaction terms between

W1 caring and linear and quadratic wave and included items that improved model fit.

Weighting

4

UKHLS has a complex sample design with multiple boost samples, clustering, and stratification; weights are provided by UKHLS.[10] We used the survey weight at baseline, which takes account of sampling design. We were unable to include weighting for the stratified growth curve models because the models did not converge, possibly as they are not designed for subgroup analysis. We explored this using sensitivity analysis by running unweighted unstratified model to compare vs weighted model to examine magnitude of differences and did not find noteworthy differences (eTable 7).

Results

Mental health trajectory: Pooled (unstratified)

Figure 2 shows pooled conditional growth curves, with carers starting at slightly lower MCS vs non-carers and the two groups converging over time as carers' MCS declines less steeply Waves 2-10. Table of results is shown in eTable 4. After adjusting for covariates, caring is associated with worse mental health at baseline by -1.11 points (-1.33, -0.90). While there is a decline in MCS each wave for all (-0.39; -0.43, -0.35), this decline is reduced among carers vs non-carers (0.09; 0.06, 0.13).

Physical health trajectory: Pooled (unstratified)

Figure 2 also shows pooled conditional growth curves, with carers and non-carers starting at similar PCS and carers declining more steeply Waves 2-10. Table of results is shown in eTable 4. After adjusting for covariates, caring is slightly associated with higher baseline PCS (0.21; -0.03, -0.45). While there is a decline in PCS each wave for all (-0.19; -0.23, -0.15), the decline is steeper among carers vs non-carers (-0.13; -0.17, -0.10).

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<u>Comparison of stratified crude model and stratified adjusted model</u>

Given some proposed confounders may mediate the causal pathway for effect

modification by ethnicity (e.g. education, employment, occupational class, income),

we included the stratified crude model (eFigure 1) in addition to the stratified

adjusted model that is shown in the main results (Figure 3). Overall, the shape of

results is similar in each ethnic group appear largely similar in the two specifications.

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eTable 1. Full sample by wave

	Sample size
Wave 1 (Dec 2008 – Mar 2011)	47,015
Wave 2 (Jan 2010 – Mar 2012)	35,946
Wave 3 (Jan 2011 – Jul 2013)	31,388
Wave 4 (Jan 2012 – Jun 2014)	28,721
Wave 5 (Jan 2013 – Jun 2015)	26,619
Wave 6 (Jan 2014 – May 2016)	23,495
Wave 7 (Jan 2015 – May 2017)	22,059
Wave 8 (Jan 2016 – May 2018)	20,533
Wave 9 (Jan 2017 – May 2019)	18,716
Wave 10 (Dec 2017 – May 2020)	17,737

Source: UK Household Longitudinal Study, Waves 1-10.

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eTable 2. Comparison of analytical sample with cases excluded due to missingness

	Analytical sample		Excluded due to missingness		Total	p-value for
	N	% / Mean (SE)	N	% / Mean (SE)	N	diff
Caring status						<0.001
Not carer	39217	83.4%	3558	93.7%	42,775	
Carer	7798	16.6%	240	6.3%	8,038	
Total	47015	100.0%	3798	100.0%	50,813	
SF-12 PCS	47,015	49.48 (0.05)	281	51.51 (0.59)	47,296	0.003
SF-12 MCS	47,015	50.48 (0.05)	281	50.45 (0.61)	47,296	0.97
Ethnicity						<0.001
African	1391	3.0%	143	3.7%	1,534	
Bangladeshi	1104	2.3%	179	4.7%	1,283	
Caribbean	1109	2.4%	119	3.1%	1,228	
Indian	1868	4.0%	202	5.3%	2,070	
Pakistani	1407	3.0%	202	5.3%	1,609	
White	35484	75.5%	2617	68.4%	38,101	
Other	4652	9.9%	364	9.5%	5,016	
Total	47015	100.0%	3826	100.0%	50,841	
Age (deciles)						<0.001
16-19	2955	6.3%	432	11.1%	3,387	
20-29	7374	15.7%	774	20.0%	8,148	
30-39	8641	18.4%	664	17.1%	9,305	
40-49	8951	19.0%	736	19.0%	9,687	
50-59	7115	15.1%	549	14.2%	7,664	
60-69	6302	13.4%	364	9.4%	6,666	
70-79	3941	8.4%	214	5.5%	4,155	
80+	1736	3.7%	142	3.7%	1,878	
Total	47015	100.0%	3875	100.0%	50,890	
Sex						<0.001
Male	20699	44.0%	2469	63.7%	23,168	
Female	26316	56.0%	1404	36.3%	27,720	
Total	47015	100.0%	3873	100.0%	50,888	
Marital status						<0.001
Married/ civil partner	23871	50.8%	2042	53.0%	25,913	

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Living as couple	5324	11.3%	398	10.3%	5,722	
Widowed	2832	6.0%	158	4.1%	2,990	
Separated/ divorced	4178	8.9%	106	2.7%	4,284	
Never married	10810	23.0%	1151	29.9%	11,961	
Total	47015	100.0%	3855	100.0%	50,870	
Number of own children under 16 in household						0.02
0	33044	70.3%	2796	72.2%	35,840	
1	6188	13.2%	444	11.5%	6,632	
2	5283	11.2%	433	11.2%	5,716	
3+	2500	5.3%	202	5.2%	2,702	
Total	47015	100.0%	3875	100.0%	50,890	
Highest educational qualification						<0.001
Degree	10172	21.6%	758	20.0%	10,930	
Other higher education	5256	11.2%	253	6.7%	5,509	
A-level or equivalent	8824	18.8%	753	19.9%	9,577	
GCSE or equivalent	9691	20.6%	811	21.4%	10,502	
Other qualification	4866	10.3%	348	9.2%	5,214	
No qualification	8206	17.5%	861	22.8%	9,067	
Total	47015	100.0%	3784	100.0%	50,799	
Limiting longstanding illness						<0.001
No	35460	75.4%	2729	94.9%	38,189	
Yes	11555	24.6%	146	5.1%	11,701	
Total	47015	100.0%	2875	100.0%	49,890	
Employment status						<0.001
Employed	25143	53.5%	2288	59.2%	27,431	
Unemployed	3146	6.7%	226	5.9%	3,372	
Retired	9642	20.5%	488	12.6%	10,130	
Family/ home care	3501	7.4%	185	4.8%	3,686	
Student/ training	3463	7.4%	436	11.3%	3,899	
LT sick/ disabled	1789	3.8%	195	5.0%	1,984	
Other	331	0.7%	45	1.2%	376	
Total	47015	100.0%	3863	100.0%	50,878	
Occupational class						0.001
Management & professional	10535	22.4%	784	21.3%	11,319	

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Intermediate	6137	13.1%	501	13.6%	6,638	
Routine	9300	19.8%	817	22.2%	10,117	
Not employed	21043	44.8%	1575	42.8%	22,618	
Total	47015	100.0%	3677	100.0%	50,692	
Net equivalized monthly household income (tertiles)						<0.001
Low	22732	48.4%	1675	43.6%	24,407	
Middle	13726	29.2%	1154	30.1%	14,880	
High	10557	22.5%	1009	26.3%	11,566	
Total	47,015	100.0%	3838	100.0%	50,853	

Source: UK Household Longitudinal Study, Wave 1.
Percentages and sample sizes unweighted

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eTable 3. Covariates and caring status by ethnicity

	African (n=1,391) % / Mean (SE)	Bangladeshi (n=1,104) % / Mean (SE)	Caribbean (n=1,109) % / Mean (SE)	Indian (n=1,868) % / Mean (SE)	Pakistani (n=1,407) % / Mean (SE)	White (n=35,484) % / Mean (SE)	Other (n=4,652) % / Mean (SE)	Total (n=47,015) % / Mean (SE)	N	p-value for % diff
Age										<0.001
16-19	9.5%	9.6%	6.1%	6.3%	11.3%	6.4%	5.7%	6.5%	2,955	
20-29	24.8%	31.0%	15.4%	25.7%	29.0%	15.5%	27.0%	16.9%	7,374	
30-39	30.9%	29.7%	16.3%	26.5%	25.6%	14.8%	26.5%	16.4%	8,641	
40-49	22.9%	13.8%	27.3%	17.3%	16.5%	18.2%	18.5%	18.3%	8,951	
50-59	7.2%	7.8%	15.6%	11.9%	9.7%	15.7%	10.0%	15.0%	7,115	
60-69	3.2%	4.4%	7.2%	7.5%	4.6%	14.1%	6.5%	13.0%	6,302	
70-79	1.3%	3.4%	8.3%	3.6%	2.8%	9.4%	4.1%	8.7%	3,941	
80+	0.3%	0.2%	3.7%	1.2%	0.5%	5.8%	1.6%	5.2%	1,736	
Continuous	35.44 (0.38)	35.30 (0.75)	45.05 (0.68)	39.04 (0.54)	35.76 (0.49)	47.67 (0.15)	39.01 (0.29)	46.45 (0.14)	47,015	<0.001
Sex										<0.001
Male	47.1%	57.5%	45.5%	54.7%	51.3%	48.8%	47.0%	48.8%	20,699	
Female	52.9%	42.5%	54.5%	45.3%	48.7%	51.2%	53.0%	51.2%	26,316	
Marital status										<0.001
Married/ civil partner	43.2%	62.9%	30.9%	63.4%	62.4%	49.5%	46.6%	49.6%	23,871	
Living as couple	6.4%	1.2%	11.2%	1.7%	1.5%	13.0%	13.3%	12.4%	5,324	
Widowed	2.4%	3.0%	4.6%	3.0%	2.5%	7.3%	3.5%	6.7%	2,832	
Separated/ divorced	8.9%	3.6%	11.6%	2.6%	5.6%	7.8%	6.6%	7.6%	4,178	
Never married	39.0%	29.2%	41.7%	29.3%	28.0%	22.4%	30.0%	23.6%	10,810	
# own children <16 in household										<0.001
0	53.3%	53.3%	70.1%	65.9%	52.5%	74.5%	67.1%	73.1%	33,044	
1	16.1%	17.2%	15.1%	15.4%	14.6%	11.8%	16.3%	12.4%	6,188	
2	18.3%	13.0%	11.3%	13.6%	15.6%	9.9%	12.0%	10.3%	5,283	
3+	12.3%	16.5%	3.5%	5.1%	17.3%	3.8%	4.6%	4.2%	2,500	
Highest qualification										<0.001
Degree	34.0%	22.3%	18.3%	42.4%	27.9%	18.6%	37.0%	20.8%	10,172	
Other higher education	15.2%	5.9%	13.8%	9.9%	7.9%	11.2%	12.0%	11.2%	5,256	

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A-level/ equiv	19.9%	22.6%	20.1%	16.8%	17.8%	20.1%	16.7%	19.7%	8,824
GCSE/ equiv	14.9%	19.0%	22.1%	13.2%	18.1%	22.1%	11.2%	21.0%	9,691
Other qual	6.3%	7.8%	10.1%	6.2%	8.2%	10.8%	10.3%	10.5%	4,866
No qual	9.7%	22.4%	15.5%	11.4%	20.2%	17.2%	12.8%	16.7%	8,206
LLI									<0.001
No	89.1%	81.9%	78.9%	84.8%	81.2%	73.8%	83.9%	75.2%	35,460
Yes	10.9%	18.1%	21.1%	15.2%	18.8%	26.2%	16.1%	24.8%	11,555
Employment status									<0.001
Employed	50.2%	45.0%	51.3%	60.1%	43.6%	55.6%	60.4%	55.8%	25,143
Unemployed	13.0%	10.4%	13.9%	7.8%	10.2%	5.6%	7.3%	6.0%	3,146
Retired	3.3%	6.0%	16.8%	8.4%	5.1%	23.9%	9.1%	21.9%	9,642
Family/ home care	9.5%	18.2%	4.2%	9.2%	21.7%	4.9%	8.1%	5.5%	3,501
Student/ training	21.1%	17.0%	8.9%	11.6%	14.7%	5.8%	11.8%	6.8%	3,463
LT sick/ disabled	2.3%	2.8%	4.3%	2.5%	3.5%	3.5%	2.6%	3.4%	1,789
Other	0.6%	0.6%	0.6%	0.4%	1.2%	0.6%	0.8%	0.7%	331
Occupational class									<0.001
Management/ professional	21.1%	13.2%	21.5%	28.9%	13.6%	23.0%	27.5%	23.3%	10,535
Intermediate	8.8%	14.2%	12.1%	14.2%	13.2%	13.7%	12.6%	13.6%	6,137
Routine	21.4%	21.1%	18.4%	20.4%	17.7%	20.8%	22.2%	20.8%	9,300
Not employed	48.7%	51.6%	48.0%	36.4%	55.5%	42.5%	37.6%	42.3%	21,043
Net equivalized monthly household income (tertiles)									<0.001
Low	61.3%	71.6%	49.1%	42.8%	74.7%	43.7%	45.3%	44.5%	22,732
Middle	25.2%	19.9%	32.4%	32.9%	18.0%	31.3%	26.6%	30.7%	13,726
High	13.5%	8.5%	18.4%	24.2%	7.2%	25.0%	28.1%	24.7%	10,557
Continuous	1126.31 (30.52)	1058.65 (62.64)	1307.41 (42.31)	1512.54 (46.68)	977.08 (39.24)	1528.27 (9.10)	1575.41 (32.09)	1515.65 (8.68)	47,015	<0.001
Caring status									<0.001
Carer	5.6%	17.6%	15.6%	11.8%	16.4%	17.3%	9.5%	16.4%	7,798
Not carer	94.4%	82.4%	84.4%	88.2%	83.6%	82.7%	90.5%	83.6%	39,217

Source: UK Household Longitudinal Study, Wave 1.

Sample size unweighted, percentage weighted

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eTable 4. Multi-level linear regression with SF-12 MCS and SF-12 PCS trajectory waves 1-10

	Model 1		Model 2	
	Coefficient	95% CI	Coefficient	95% CI
SF-12 MCS				
Caring status W1				
Not carer	Ref	-	Ref	-
Carer	-1.07	-1.29- -0.85	-1.11	-1.33- -0.90
W1 Caring#Wave interaction				
Not carer#Wave	Ref	-	Ref	-
Carer#Wave	0.09	0.06- 0.13	0.09	0.06- 0.13
Wave	-0.38	-0.42- -0.34	-0.39	-0.43- -0.35
Wave-squared	0.02	0.01- 0.02	0.02	0.01- 0.02
Constant	48.18	47.97- 48.39	49.93	49.50- 50.37
Random Effects:				
Var(Wave)	4.52	4.24- 4.81	4.54	4.26- 4.83
Var(Wave-squared)	0.05	0.04- 0.05	0.05	0.04- 0.05
Var(Cons)	49.76	48.38- 51.17	45.18	43.88- 46.51
Cov(Wave, Wave-squared)	-0.43	-0.46- -0.40	-0.43	-0.46- -0.40
Cov(Wave, Cons)	-5.01	-5.52- -4.49	-4.78	-5.29- -4.38
Cov(Wave-squared, Cons)	0.35	0.29- 0.40	0.33	0.28- 0.38
Var(Residual)	40.54	40.00- 41.09	40.50	39.96- 41.05
SF-12 PCS				
Caring status W1				
Not carer	Ref	-	Ref	-
Carer	0.42	0.16- 0.68	0.21	-0.03- 0.45
W1 Caring#Wave interaction				
Not carer#Wave	Ref	-	Ref	-
Carer#Wave	-0.14	-0.17- -0.10	-0.13	-0.17- -0.10
Wave	-0.17	-0.21- -0.13	-0.19	-0.23- -0.15
Wave-squared	-0.01	-0.01- -0.01	-0.01	-0.01- -0.00
Constant	62.45	62.22- 62.67	61.33	60.88- 61.79
Random Effects:				
Var(Wave)	4.04	3.81- 4.28	4.05	3.82- 4.30
Var(Wave-squared)	0.04	0.04- 0.04	0.04	0.04- 0.04
Var(Cons)	78.65	76.98- 80.35	59.94	58.52- 61.39
Cov(Wave, Wave-squared)	-0.36	-0.39- -0.34	-0.37	-0.39- -0.34
Cov(Wave, Cons)	-3.52	-3.97- -3.08	-3.25	-3.67- -2.83
Cov(Wave-squared, Cons)	0.15	0.10- 0.20	0.14	0.09- 0.18
Var(Residual)	30.54	30.11- 30.98	30.48	30.05- 30.92

Source: UK Household Longitudinal Study, Waves 1-10.

Weighted using survey weight at baseline.

Model 1 adjusted for baseline age, sex

Model 2 additionally adjusted for baseline marital status, # own children under 16 in household, highest educational qualification, LLI (for MCS), employment status, occupational class, net equivalized monthly household income

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eTable 5. Multi-level linear regression with SF-12 MCS and SF-12 PCS trajectory waves 1-10, with ethnicity interaction

	Model 1		Model 2	
	Coefficient	95% CI	Coefficient	95% CI
SF-12 MCS				
Caring status W1				
Not carer	Ref	-	Ref	-
Carer	-0.88	-3.07- 1.32	-0.68	-2.90- 1.55
W1 Caring#Wave interaction				
Not carer#Wave	Ref	-	Ref	-
Carer#Wave	-0.28	-0.81- 0.25	-0.29	-0.81- 0.23
Wave	-0.34	-0.46- -0.21	-0.34	-0.46- -0.22
Wave-squared	0.02	0.01- 0.02	0.02	0.01- 0.02
Ethnicity#Care#Wave interaction				
African#Care#Wave	Ref *	-	Ref **	-
Bangladeshi#Care#Wave	0.34	-0.34- 1.02	0.31	-0.36- 0.98
Caribbean#Care#Wave	0.20	-0.42- 0.83	0.23	-0.39- 0.84
Indian#Care#Wave	0.32	-0.27- 0.91	0.34	-0.24- 0.92
Pakistani#Care#Wave	0.43	-0.15- 1.01	0.42	-0.15- 1.00
White#Care#Wave	0.38	-0.15- 0.91	0.39	-0.14- 0.91
Other#Care#Wave	0.36	-0.20- 0.91	0.36	-0.19- 0.91
Constant	48.56	48.00- 49.12	50.69	50.00- 51.38
Random Effects:				
Var(Wave)	4.52	4.25- 4.82	4.54	4.26- 4.83
Var(Wave-squared)	0.05	0.04- 0.05	0.05	0.04- 0.05
Var(Cons)	49.67	48.29- 51.09	45.11	43.82- 46.45
Cov(Wave, Wave-squared)	-0.43	-0.46- -0.40	-0.43	-0.46- -0.40
Cov(Wave, Cons)	-5.02	-5.53- -4.50	-4.79	-5.29- -4.29
Cov(Wave-squared, Cons)	0.35	0.29- 0.40	0.33	0.28- 0.28
Var(Residual)	40.53	39.99- 41.08	40.49	39.95- 41.04
SF-12 PCS				
Caring status W1				
Not carer	Ref	-	Ref	-
Carer	-1.59	-3.67- 0.50	-1.83	-3.83- 0.17
W1 Caring#Wave interaction				
Not carer#Wave	Ref	-	Ref	-
Carer#Wave	0.17	-0.30- 0.64	0.19	-0.27- 0.65
Wave	-0.22	-0.33- -0.11	-0.26	-0.37- -0.15
Wave-squared	-0.01	-0.01- -0.01	-0.01	-0.01- -0.00
Ethnicity#Care#Wave interaction				
African#Care#Wave	Ref ***	-	Ref ****	-
Bangladeshi#Care#Wave	0.14	-0.42- 0.69	0.11	-0.44- 0.65
Caribbean#Care#Wave	-0.35	-0.92- 0.22	-0.34	-0.90- 0.21
Indian#Care#Wave	-0.14	-0.65- 0.38	-0.14	-0.65- 0.36
Pakistani#Care#Wave	-0.27	-0.80- 0.26	-0.29	-0.81- 0.23
White#Care#Wave	-0.31	-0.78- 0.16	-0.33	-0.79- 0.13
Other#Care#Wave	-0.32	-0.81- 0.17	-0.34	-0.83- 0.14
Constant	62.67	62.14- 63.19	62.20	61.55- 62.85
Random Effects:				
Var(Wave)	4.04	3.81- 4.29	4.05	3.82- 4.30
Var(Wave-squared)	0.04	0.04- 0.04	0.04	0.04- 0.04
Var(Cons)	78.29	76.61- 80.01	59.71	58.29- 61.17
Cov(Wave, Wave-squared)	-0.37	-0.39- -0.34	-0.37	-0.39- -0.34
Cov(Wave, Cons)	-3.61	-4.06- -3.16	-3.31	-3.74- -2.89
Cov(Wave-squared, Cons)	0.16	0.11- 0.21	0.14	0.10- 0.19
Var(Residual)	30.53	30.10- 30.97	30.47	30.04- 30.90

Source: UK Household Longitudinal Study, Waves 1-10.

Weighted using survey weight at baseline.

* Test for interaction (testparm): $F=3.48$ $p=0.75$

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** Test for interaction (testparm): F=3.44 p=0.75
*** Test for interaction (testparm): F=13.43 p=0.037
**** Test for interaction (testparm): F=13.32 p=0.038
Model 1 adjusted for baseline age, sex, nativity, ethnicity, ethnicity*care
interaction, ethnicity*wave interaction
Model 2 additionally adjusted for baseline marital status, # own children under 16
in household, highest educational qualification, LLI (for MCS), employment status,
occupational class, net equivalized monthly household income

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eTable 6. Multi-level linear regression with SF-12 PCS trajectory waves 1-10, stratified by ethnic group

	African		Bangladeshi		Caribbean		Indian		Pakistani		White		Other	
	Coef	95% CI	Coef	95% CI	Coef	95% CI	Coef	95% CI	Coef	95% CI	Coef	95% CI	Coef	95% CI
Caring status W1														
Not carer	Ref	-	Ref	-	Ref	-	Ref	-	Ref	-	Ref	-	Ref	-
Carer	-1.93	-3.52- -0.34	-2.01	-3.25- -0.78	-0.43	-1.86-0.99	-1.30	-2.33- -0.27	-1.16	-2.25- -0.08	0.35	0.10-0.60	-0.31	-1.04-0.43
W1 Caring#Wave interaction														
Not carer#Wave	Ref	-	Ref	-	Ref	-	Ref	-	Ref	-	Ref	-	Ref	-
Carer#Wave	0.16	-0.22-0.55	0.24	-0.02-0.51	-0.20	-0.47-0.07	0.05	-0.15-0.24	-0.06	-0.27-0.15	-0.14	-0.18- -0.10	-0.17	-0.31- -0.04
Wave	-0.64	-0.90- -0.39	-0.96	-1.25- -0.66	-0.26	-0.54-0.02	-0.49	-0.70- -0.29	-0.80	-1.04- -0.56	-0.16	-0.20- -0.12	-0.35	-0.47- -0.23
Wave-squared	0.04	0.01-0.07	0.08	0.05-0.12	0.00	-0.03-0.03	0.03	0.01-0.05	0.07	0.04-0.09	-0.01	-0.02- -0.01	0.01	0.00-0.03
Constant	63.99	61.61-66.37	65.53	62.19-68.88	62.49	58.82-66.17	61.08	59.08-63.08	61.50	58.82-64.17	62.21	61.62-62.80	60.24	58.93-61.56
Random Effects:														
Var(Wave)	2.91	1.80-4.70	1.33	0.37-4.76	4.83	3.43-6.79	3.69	2.76-4.93	2.57	1.52-4.34	3.46	3.27-3.66	3.15	2.59-3.83
Var(Wave-squared)	0.03	0.02-0.05	0.01	0.00-0.07	0.05	0.03-0.07	0.04	0.03-0.05	0.03	0.01-0.05	0.03	0.03-0.03	0.03	0.02-0.04
Var(Cons)	21.81	17.89-26.59	28.71	23.05-35.76	51.09	44.52-58.62	30.43	26.59-34.82	33.21	28.26-39.02	64.53	63.22-65.87	37.78	35.14-40.60
Cov(Wave, Wave-squared)	-0.26	-0.41- -0.11	-0.11	-0.29-0.076	-0.45	-0.63- -0.27	-0.35	-0.46- -0.23	-0.23	-0.38- -0.08	-0.30	-0.32- -0.28	-0.28	-0.35- -0.22
Cov(Wave, Cons)	0.07	-2.01-2.14	0.29	-2.48-3.07	-2.61	-5.40-0.18	-2.24	-3.95- -0.53	-1.02	-3.24-1.19	-2.66	-3.07- -2.25	-1.94	-3.01- -0.87
Cov(Wave-squared, Cons)	-0.12	-0.35-0.11	-0.11	-0.42-0.19	0.13	-0.18-0.44	0.13	-0.05-0.31	-0.06	-0.30-0.18	0.06	0.02-0.11	0.10	-0.02-0.21
Var(Residual)	36.75	34.72-38.90	44.54	41.62-47.67	36.89	34.89-39.01	37.50	35.97-39.09	42.31	40.23-44.51	31.83	31.57-32.08	33.56	32.71-34.44

Source: UK Household Longitudinal Study, Waves 1-10.

Model adjusted for baseline age, sex, marital status, # own children under 16 in household, highest educational qualification, employment status, occupational class, net equivalized monthly household income, and nativity.

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eTable 7. Sensitivity analysis: Unweighted multi-level linear regression with SF-12 PCS trajectory waves 1-10

	Model 1		Model 2	
	Coefficient	95% CI	Coefficient	95% CI
SF-12 MCS				
Caring status W1				
Not carer	Ref	-	Ref	-
Carer	-1.07	-1.28- -0.86	-1.12	-1.33- -0.92
W1 Caring#Wave interaction				
Not carer#Wave	Ref	-	Ref	-
Carer#Wave	0.09	0.06- 0.13	0.09	0.06- 0.13
Wave	-0.35	-0.39- -0.31	-0.36	-0.40- -0.32
Wave-squared	0.01	0.01- 0.02	0.01	0.01- 0.02
Constant	48.06	47.85- 48.28	49.88	49.45- 50.31
Random Effects:				
Var(Wave)	3.69	3.47- 3.92	3.68	3.47- 3.92
Var(Wave-squared)	0.04	0.03- 0.04	0.04	0.03- 0.04
Var(Cons)	49.69	48.60- 50.81	44.49	43.46- 45.54
Cov(Wave, Wave-squared)	-0.34	-0.36- -0.31	-0.34	-0.36- -0.31
Cov(Wave, Cons)	-4.13	-4.55- -3.72	-3.77	-4.17- -3.37
Cov(Wave-squared, Cons)	0.26	0.21- 0.30	0.23	0.19- 0.27
Var(Residual)	43.70	43.38- 44.02	43.71	43.39- 44.03
SF-12 PCS				
Caring status W1				
Not carer	Ref	-	Ref	-
Carer	0.37	0.13- 0.61	0.15	-0.06- 0.37
W1 Caring#Wave interaction				
Not carer#Wave	Ref	-	Ref	-
Carer#Wave	-0.13	-0.16- -0.09	-0.13	-0.16- -0.09
Wave	-0.20	-0.23- -0.16	-0.22	-0.26- -0.18
Wave-squared	-0.01	-0.01- -0.00	-0.00	-0.01- -0.00
Constant	62.38	62.13- 62.64	61.20	60.72- 61.68
Random Effects:				
Var(Wave)	3.45	3.27- 3.63	3.44	3.27- 3.62
Var(Wave-squared)	0.03	0.03- 0.03	0.03	0.03- 0.03
Var(Cons)	78.46	77.13- 79.82	58.81	57.72- 59.91
Cov(Wave, Wave-squared)	-0.30	-0.32- -0.28	-0.30	-0.32- -0.28
Cov(Wave, Cons)	-2.69	-3.08- -2.29	-2.33	-2.69- -1.98
Cov(Wave-squared, Cons)	0.06	0.02- 0.11	0.05	0.01- 0.08
Var(Residual)	32.67	32.43- 32.91	32.66	32.43- 32.90

Source: UK Household Longitudinal Study, Waves 1-10.

Model 1 adjusted for baseline age, sex

Model 2 additionally adjusted for baseline marital status, # own children under 16 in household, highest educational qualification, LLI (for MCS), employment status, occupational class, net equivalized monthly household income

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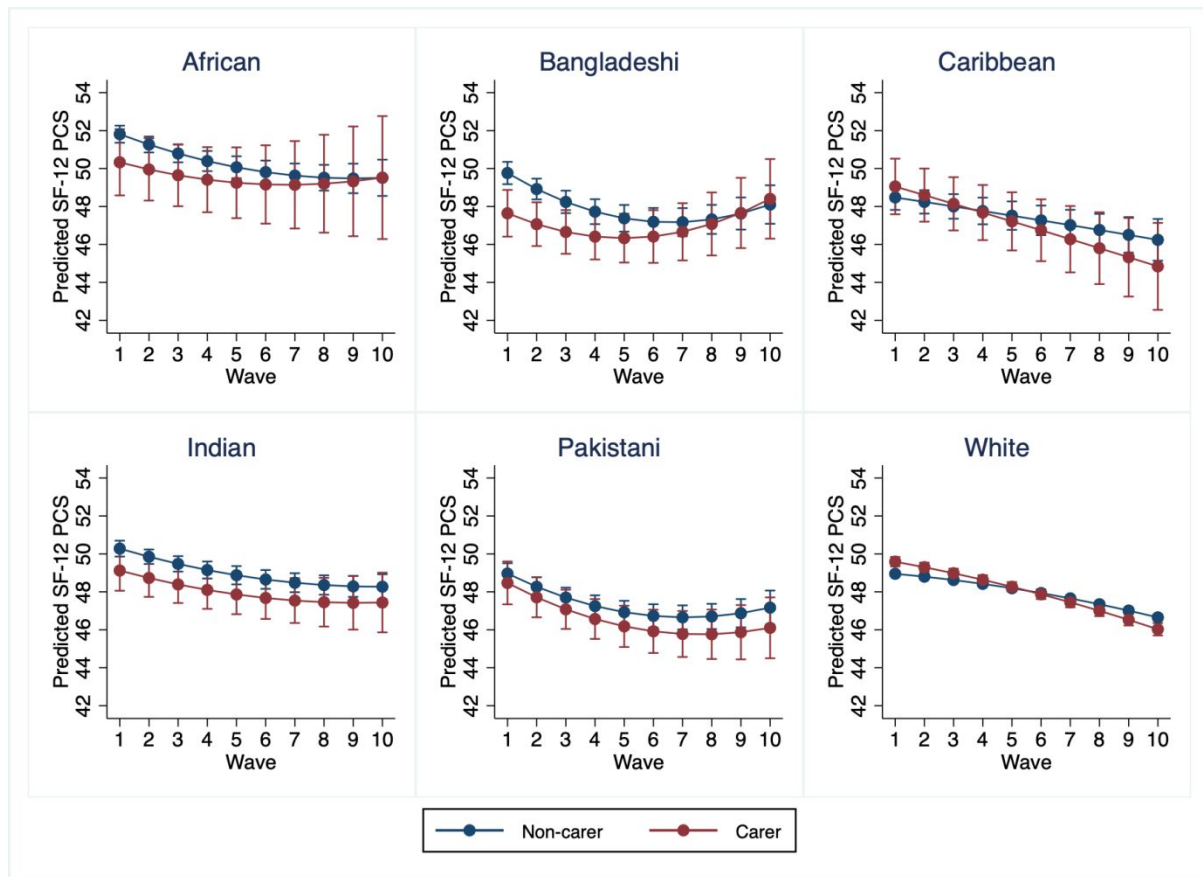
eFigure 1. Predicted SF-12 PCS Waves 1-10 by ethnicity, crude
Source: UK Household Longitudinal Study, Waves 1-10.
Model adjusted for baseline age, sex, and nativity. Model includes linear and quadratic term for wave.

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