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A randomised trial found online questionnaires supplemented by postal reminders generated a cost-effective and generalisable sample, but don't forget the reminders

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ABSTRACT

Objective

To compare the response rates, data completeness and representativeness of survey data produced by online and postal surveys.

Study Design and Setting

A randomised trial nested within a cohort study in Yorkshire, United Kingdom. Participants were randomised to receive either an electronic (online) survey questionnaire with paper reminder (N=2982), or paper questionnaire with electronic reminder (N=2855).

Results

Response rates were similar for electronic contact and postal contacts (50.9% versus 49.7%, difference = 1.2%, 95% confidence interval -1.3% to 3.8%). The characteristics of those responding to the two groups were similar. Participants nevertheless demonstrated an overwhelming preference for postal questionnaires, with the majority responding by post in both groups.

Conclusion

Online survey questionnaire systems need to be supplemented with a postal reminder to achieve acceptable uptake, but doing so provides a similar response rate and case mix when compared to postal questionnaires alone. For large surveys, online survey systems may be cost saving.

Key Words: RCTs, surveys, questionnaires, response rates, external validity

Running Title: Online questionnaires with postal reminders are cost-effective.

WHAT IS NEW

Online survey questionnaires are a cost-effective way of collecting data from large health surveys, but uptake is lower than traditional postal questionnaires.

Our randomised trial found electronic mail contact, followed by postal reminder if necessary, yielded a response rate and population mix comparable to that achieved by standard postal questionnaires.

Researchers undertaking large population surveys should consider this two-stage approach when contacting potential participants, but in smaller studies the benefits are less obvious.

1. Background

Obtaining data via self-completed questionnaires is an inexpensive but challenging method of data collection. Research studies – both medical and non-medical - often recruit or follow-up their participants via postal questionnaires but the resultant response rate is often low, which in turn reduces the power of the study and raises questions over the generalisability of the results [1]. This phenomenon and its implications are best illustrated by a 2002 systematic review which identified 292 randomised trials of approaches to increase uptake to postal questionnaires [2]. Moreover, response rates for large cross-sectional surveys have generally declined over the last half century [3,4].

Recent years have seen an increased use of online questionnaire entry, in which participants enter their data directly onto a web-based database system (online surveys). Online survey systems offer an efficient way to capture data with several potential advantages: they can be configured to flag erroneous or incomplete data to the participant at the point of entry (which otherwise would be missed), reduce the risk of transcription errors in data entry, and remove the cost of postage and data entry staff. Despite this, the viability of using such a system remains unclear on two grounds; namely the response rate associated with this medium, and the generalisability of participants who do so. In particular, previous studies have reported electronic contact to have an inferior response rate compared to usual paper questionnaires in health research and other settings [5–7].

The impact on generalisability is less clear. Previous work has suggested that internet follow-up creates case-mix bias whereby different people respond to particular methods of follow-up [8]. A large proportion of the population now have access to the internet. It may no longer be true that those with access to the internet are better educated, younger, wealthier and healthier as was once the case [9], and a recent survey reported similar characteristics of people with and without valid e-mail addresses [10], although a second study found females were more engaged with electronic communication than men [11]. Certainly, web-based questionnaires are only useful in people who are computer literate and who frequently open their mail [12]. Nevertheless, the continued increase in internet communication means these preferences may rapidly change.

This paper reports a trial, nested in a population cohort, in which individuals were randomised to receive either a postal or online questionnaire. Of primary interest are the proportion of participants responding, the means by which they responded, as well as the levels of data completeness for electronic and paper questionnaires. We also assess the implications of using an online survey on participant representativeness and cost. We conclude by presenting our experiences of using an online survey system on other research projects.

2. Methods

2.1 Setting

The trial was nested within the Yorkshire Health Study (YHS, formerly South Yorkshire Cohort), a large scale cohort study collecting information on general health and wellbeing among the general population in the Yorkshire region of the UK. The study has been described in detail elsewhere [13]. In the first wave of data collection, eligible participants were aged between 16 and 85 and were registered at one of 43 participating GP surgeries in the South Yorkshire region. Potential participants received an invitation letter sent from their GP and a single, 8-page health questionnaire sent out between 2010 and 2012. A total of 27806 participants returned their questionnaire, with a return rate

of 15.9%. The questionnaire contained the question “Do you wish to be contacted again?” to which 22179 people agreed. Of these, 8101 provided an email address which could be used to contact them, and these individuals formed the basis of our nested trial when a “second wave” mailout was undertaken between 2013 and 2015. Individuals who had provided an email address were randomised to receive either electronic or paper contact in this second wave.

The electronic completion arm was contacted by email with a link to complete the questionnaire online (Appendix A). If no responses were received within a month, a questionnaire containing the same questions but in the form of an 8-page booklet was sent by post. Invalid email addresses were identified automatically by the mailout system and these were checked against the original data for transcription errors and corrected where possible before the batch email was sent. As per the intention to treat principle, individuals with incorrect email addresses were considered to have been non-responses unless they returned their subsequent postal questionnaire; the same rule was applied to those with apparently valid addresses that returned undelivered. The postal questionnaire was sent out 4-6 weeks later irrespective of whether the email had been delivered successfully. The online survey system did not contain mandatory fields other than the consent questions and contact details for those who agreed to be contacted again, but did display a summary screen to make participants aware of any missing questions (see example in appendix B). To prevent entry of impossible data, some point of entry rules were applied to the electronic questionnaire (see appendix C). The control group initially received an identical questionnaire by post and were asked to return; if after a month no response had been obtained, a reminder was sent via email with a link to complete the questionnaire online. The study team were aware of non-delivered postal questionnaires but again did not alter the timing of the electronic mail contact schedule for these individuals; again, these were considered non-responders unless they completed their questionnaire online. The randomisation schedule was prepared by a statistician not involved in the study and was stratified by the participant’s age and GP (as a proxy for socioeconomic status), with half of the participants within each stratum randomised to each contact.

2.2 Outcomes

The primary endpoint was the proportion of participants who responded with a questionnaire, both overall and within one month, after which time a reminder was scheduled to be sent. The time to response, the completeness of key questionnaire items and the characteristic of responders were also compared. The primary analysis was by intention to treat in which participants were analysed according to their randomised group, and the characteristics of responders was also compared according to the route by which the response was received. For reference, the characteristics of survey participants that were not involved in the trial are also reported. We have not attempted a formal cost-effectiveness analysis since the cost of developing an online survey system and the staffing resource used are highly context dependent, but we conclude by presenting the costs of setting up the system, and the expected savings in postage and data entry.

2.3 Statistical considerations

The sample size was constrained by the number of participants providing an email address in the original mailout. Nevertheless, the trial had a high power to detect differential response rates, with 2100 participants per arm required for a 90% power to detect a 5% absolute difference in response rates, using a chi-squared test with a two-sided 5% level of significance. The anticipated sample size of around 4000 per arm gives a power of 99% to detect this difference.

2.4 Ethics and funding

The YHS was funded by the UK National Institute of Health Research, Collaboration for Leadership in Applied Health Research and Care for Yorkshire and Humber (NIHR CLAHRC YH). Ethical approval was granted by the East Leeds Research Ethics Committee (REC ref: 09/H1306/97). Institutional ethical approval was granted for this nested trial.

3. Results

3.1 Participant characteristics

The participant flow is summarised in figure 1. Of the 8101 participants having originally consented to being contacted electronically, 85 died or withdrew consent in the intervening three years and nine practices (n=2076) did not take part in the second mailout during the time frame of the trial. The mailout incorporated an internal pilot phase in which participants in the first practice were re-randomised to receive a shortened, 4-page questionnaire. The 8-page questionnaire was used for all subsequent mailouts and participants who received the 4-page questionnaire (n=103) were excluded from this trial, leaving 5837 participants who were included in the analyses. A second, unplanned per-protocol analysis was undertaken to address a delay in sending reminders affecting nine practices (2379 participants) wherein reminders were sent after the planned 4-6 weeks following the first contact. The per-protocol analysis was restricted to n=3458 individuals for whom reminders were sent on time.

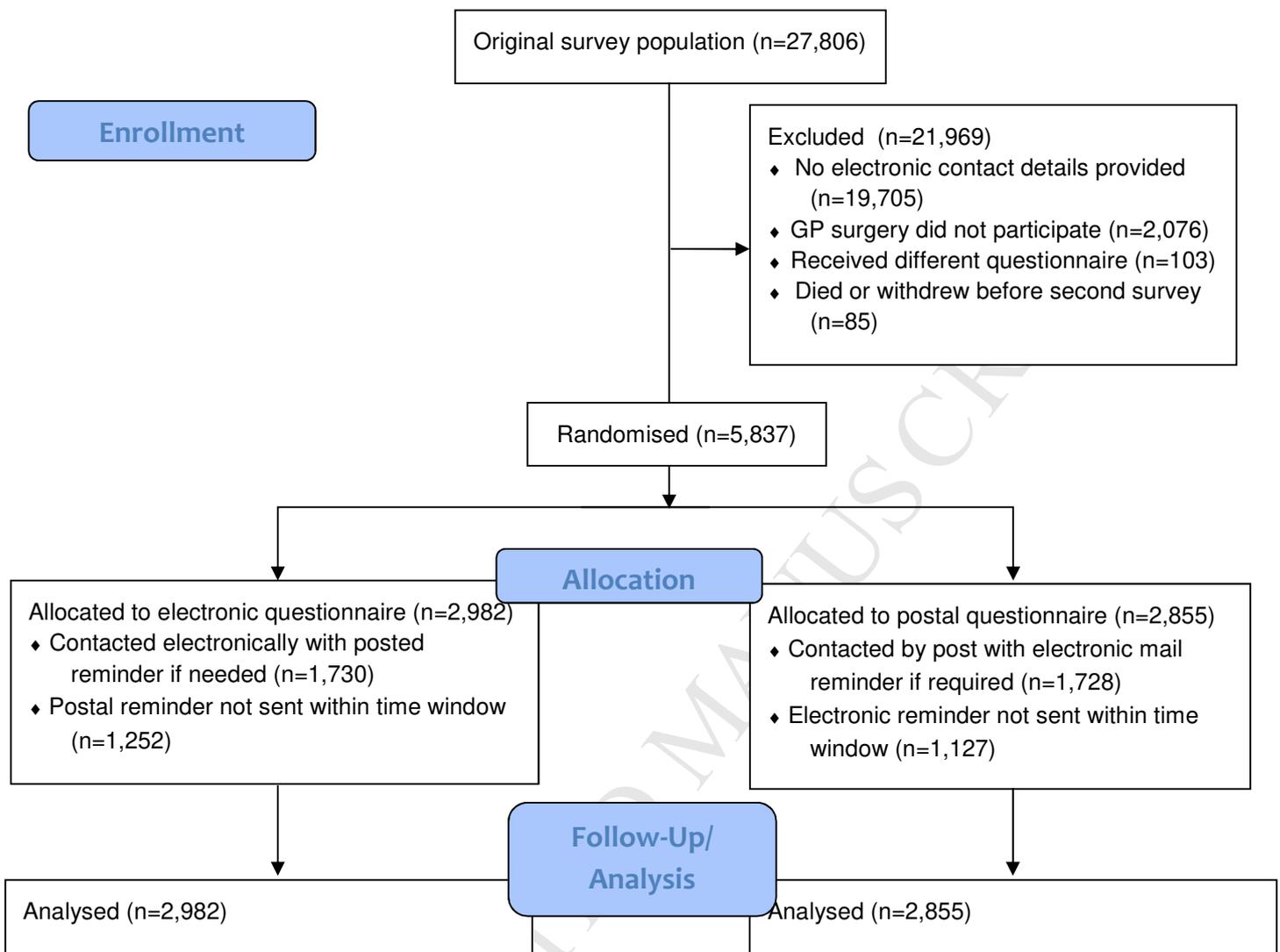


Figure 1 Participant flow

The characteristics of the participants are presented in table 1, along with the breakdown of those that originally provided an electronic address and the entire YHS cohort (within which the trial population was nested) for reference. The trial participants were more likely to be in the age range 26-55 compared to the cohort and tended to come from less deprived areas; the proportion of females was very slightly lower.

	Electronic questionnaire (N=2982)	Postal questionnaire (N=2855)	Individuals providing email address (N=8045)	Entire cohort (N=27810)
Age				
Mean (SD)	48.7 (15.8)	48.6 (15.6)	48.5 (15.9)	54.5 (17.2)
16-25	146 (4.9%)	156 (5.5%)	9.5%	6.9%
26-35	370 (12.4%)	357 (12.5%)	14.2%	9.7%
36-45	492 (16.5%)	462 (16.2%)	17.9%	13.0%
46-55	603 (20.2%)	560 (19.6%)	19.7%	16.9%
56-65	661 (22.2%)	644 (22.6%)	23.2%	22.2%
66-75	546 (18.3%)	490 (17.2%)	11.9%	20.1%
76+	152 (5.1%)	173 (6.1%)	2.7%	9.9%
Missing	12 (0.4%)	13 (0.5%)	0.9%	1.2%
Sex				
Male	1316 (44.1%)	1278 (44.8%)	44.6%	43.8%
Female	1666 (55.9%)	1577 (55.2%)	55.4%	56.2%
Indices of Deprivation 2010 Quintile				
Least deprived	704 (23.6%)	665 (23.3%)	17.3%	14.5%
Low deprivation	814 (27.3%)	780 (27.3%)	23.7%	25.2%
Average	515 (17.3%)	510 (17.9%)	20.0%	16.6%
High deprivation	322 (10.8%)	328 (11.5%)	16.3%	18.3%
Most deprived	623 (20.9%)	571 (20.0%)	22.3%	25.1%
Missing	4 (0.1%)	1 (0.0%)	0.3%	0.3%

Table 1 Characteristics of the study population

3.2 Participant response

The response rates are presented in table 2. The response rates were similar (50.9% in the electronic contact group compared to 49.7% in the postal group, difference=1.2%, 95% confidence interval - 1.3% to 3.8%), but were markedly different at 30 days (19.2% in the electronic group compared to 38.5% in the paper group, difference=19.3%, 95% confidence interval 17.1% to 21.6%). The difference was largely due to a preference for paper questionnaire, with the majority of responses being received by post in both groups. Of the 1518 participants responding in the electronic mail group, 956 did so via their posted reminder questionnaire with only 562 received via online data entry. Among those randomised to paper questionnaire, 1301 of the 1418 respondents returned their questionnaire by post and 117 did so online. Similar results were observed when restricting the analysis to participants receiving their reminders within six weeks (per protocol: response rates for email and paper 51.2% v 48.7% overall, 19.3% v 38.9% at 30 days).

	Electronic questionnaire (N=2982)	Postal questionnaire (N=2855)
Responded	1518 (50.9%)	1418 (49.7%)
Response received within 30 days	572 (19.2%)	1100 (38.5%)
Received electronically	562 (18.8%)	117 (4.1%)
Received by post	956 (32.1%)	1301 (45.6%)
Failed electronic mail delivery	360 ^a	48
Failed postal delivery	42	34 ^b

^a 144/360 with failed email address responded via post ^b 1/34 with failed postal delivery responded via email

Table 2 Response rates according to randomised group

Figure 2 illustrates the response rate by time taken to return the questionnaire and method of response. For participants randomised to electronic contact, 469/2982 (15.7%) responded within 7 days including 247 who responded on the same day the email was sent. The median time to response among those responding online was 1 day (interquartile range (IQR) 0 to 6 days), and was 45 days (IQR 4 to 63 days) when including participants who responded by post. For the paper questionnaire group the median time to response was 12 days (IQR 7 to 21 days) for those responding by post and 13 days (IQR 7 to 27 days) for the group as a whole.

a) Electronic questionnaire group

b) Paper questionnaire group

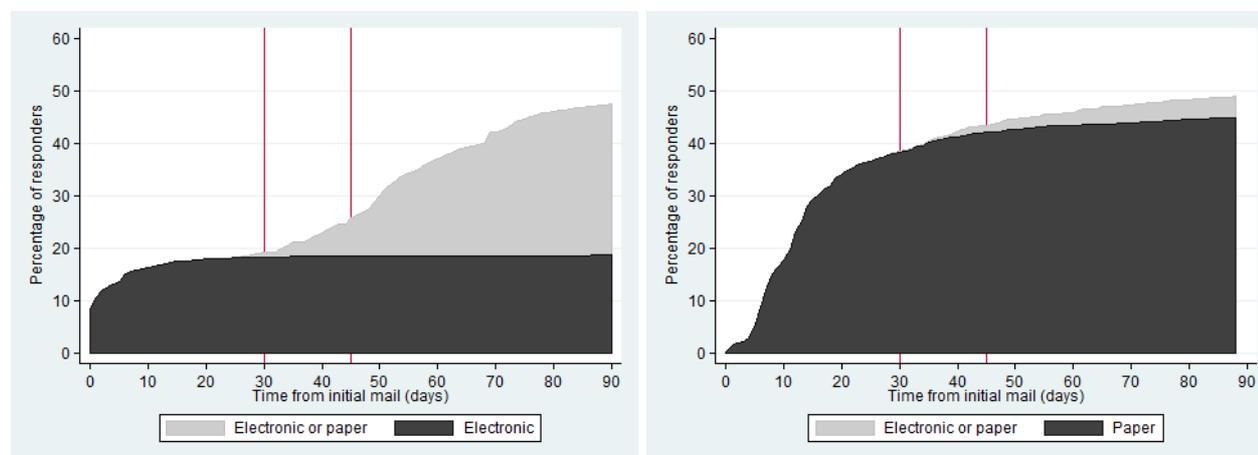


Figure 2 Proportion of questionnaires received by randomised group, timing and method of response

3.3 Relationship between method of response and participant characteristics

Table 3 describes the proportion and method of responses by age, sex and socioeconomic status. The proportion of responders increased with age and with SES; males had a slightly higher response rate than females. Among those that responded, the uptake of online data entry was proportionately highest among participants aged 25-34 and lowest among those aged over 65; no pattern was obvious in relation to sex or SES.

	Number contacted	Responded online (%)	Responded by post (%)	No response (%)	Ratio of paper:online ^a
Overall	5837	679 (11.6%)	2257 (38.7%)	2901 (59.7%)	3.3
Age					
16-24	302	19 (6.3%)	54 (17.9%)	229 (75.8%)	2.8
25-34	727	75 (10.3%)	154 (21.2%)	498 (68.5%)	2.1
35-44	954	80 (8.4%)	257 (26.9%)	617 (64.7%)	3.2
45-54	1163	140 (12.0%)	442 (38.0%)	581 (50.0%)	3.2
55-64	1305	202 (15.5%)	617 (47.3%)	486 (37.2%)	3.1
65-74	1036	135 (13.0%)	546 (52.7%)	355 (34.3%)	4.0
75+	325	28 (8.6%)	186 (57.2%)	111 (34.2%)	6.6
Missing	25	0 (0.0%)	1 (4.0%)	24 (96.0%)	-
Sex					
Male	2594	286 (11.0%)	1041 (40.1%)	1267 (48.8%)	3.6

Female	3243	393 (12.1%)	1216 (37.5%)	1634 (50.4%)	3.1
Socioeconomic status					
Least deprived	1369	183 (13.4%)	605 (44.2%)	581 (42.4%)	3.3
Low deprivation	1594	232 (14.6%)	705 (44.2%)	657 (41.2%)	3.0
Average	1025	111 (10.8%)	384 (37.5%)	530 (51.7%)	3.5
High deprivation	650	58 (8.9%)	231 (35.5%)	361 (55.5%)	4.0
Most deprived	1194	91 (7.6%)	331 (27.7%)	772 (64.7%)	3.6
Missing	5	4 (80.0%)	1 (20.0%)	0 (0.0%)	0.3

^a ratio is defined as number of responses by paper to each electronic response

Table 3 Method of response according to age, gender and socio-economic status

Table 4 shows the characteristics of responders according to randomised group and by the method of response. The characteristics of the invitees who had not previously provided email addresses and therefore not eligible for the trial are also provided; in total, 8265 (50.0%) of the 16538 invited outside of the trial responded. Those responding electronically were on average 3 years younger and contained proportionately more females than those responding by paper. Other characteristics which differed were presence of long term conditions, smoking status, the percentage employed and retired, and number of children, which may in turn reflect the discrepancy in ages. The trial population as a whole were on average younger than the wider cohort and reported higher alcohol intake, higher income and being from less deprived backgrounds overall.

	As randomised		As responded		Non-trial cohort (N=8265)
	Electronic (N=1518)	Postal (N=1418)	Electronic (N=679)	Postal (N=2257)	
Age [Mean (SD)]	56.5 (13.9)	56.6 (14.6)	54.5 (14.1)	57.2 (14.2)	62.8 (14.6)
Female	55%	55%	58%	54%	58%
Lives with spouse/partner	78%	78%	77%	79%	71%
Has carer	2%	2%	2%	3%	6%
Weight (kg) [Mean (SD)]	76.1 (16.1)	75.4 (15.7)	76.5 (16.3)	75.5 (15.8)	75.2 (17.0)
BMI (kg/m ²) [Mean (SD)]	26.1 (4.6)	26.0 (4.7)	26.3 (4.8)	26.0 (4.6)	26.5 (5.4)
Any long term health conditions	55%	59%	49%	59%	60%
Smoking status					
Current smoker	7%	5%	5%	6%	9%
Ex-smoker	38%	38%	37%	38%	34%
Never smoker	56%	57%	58%	56%	56%

Frequency of alcohol consumption					
Never	10%	9%	11%	9%	18%
Monthly or less	14%	16%	13%	16%	20%
2-4 per month	25%	27%	28%	26%	23%
3-4 per week	31%	29%	29%	31%	25%
4+ per week	19%	19%	19%	19%	14%
No. of children in household					
None	76%	74%	78%	75%	82%
1	11%	12%	11%	12%	9%
2	10%	11%	9%	12%	8%
3 or more	2%	3%	2%	2%	2%
Employment status					
Employed	54%	53%	58%	52%	35%
Homemaker/carer	4%	4%	3%	4%	7%
Unemployed/ long term sick	3%	3%	2%	3%	5%
Student	1%	1%	2%	1%	1%
Retired	38%	39%	35%	40%	53%
Monthly income					
Below £1000	13%	12%	14%	12%	28%
£1000-1999	28%	28%	32%	27%	34%
£2000-2999	23%	25%	13%	27%	19%
£3000 -3999	16%	17%	20%	16%	10%
Above £4000	20%	18%	20%	19%	9%
Socioeconomic status					
Least deprived	26%	28%	28%	27%	16%
Low deprivation	31%	31%	31%	31%	24%
Average	19%	17%	20%	18%	19%
High deprivation	9%	10%	7%	10%	18%
Most deprived	14%	14%	14%	15%	22%

Table 4 Comparison of participants by randomised group, participants by response route, and the non-randomised health cohort

3.4 Data completeness in relation to method of response

Finally, table 5 describes the response to key questions within the questionnaire. Completion was high (>95%) for all key questions with the exception of waist measurement for which paper responses were more likely to be filled in than the online survey system (96% versus 81%). This difference can be attributed to the inclusion of a tape measure in the postal response group. To address this, the online survey system was amended part way through the study to allow participants to enter their dress size (women) or trouser measurement (men), from which the waist circumference could be estimated. After this amendment was made, around three-quarters of the participants that responded online chose to enter this alternative measurement.

Item	Online responders (N=679)	Postal responders (N=2257)	Overall (N=2236)
Sex	679 (100%)	2257 (100%)	2936 (100%)
Date of Birth	675 (99.4%)	2204 (97.7%)	2879 (98.1%)
Height	679 (100%)	2223 (98.5%)	2902 (98.8%)
Weight	672 (99.0%)	2192 (97.1%)	2864 (97.5%)
Waist measurement	549 (80.9%)	2165 (95.9%)	2714 (92.4%)
How often do you have a drink containing alcohol	679 (100%)	2256 (100.0%)	2935 (100.0%)
Smoking status	679 (100%)	2256 (100.0%)	2935 (100.0%)
Any long term health conditions	678 (99.9%)	2175 (96.4%)	2853 (97.2%)

Table 5 Response rate for key questionnaire items

3.5 Cost implications

Online survey systems vary considerably in capability and hence cost, ranging from simple online forms to custom-built systems. We have therefore not attempted to quantify the costs of an online survey system, but provide a basic framework for evaluating the financial considerations. We estimated the projected costs of two strategies: 1) postal questionnaire only and 2) electronic mail followed by postal questionnaire if no response is received within 30 days. The set-up of the database to allow entry of paper questionnaire is the same for both and therefore does not need incorporating in the comparison. We have not considered the postal questionnaire + electronic reminder strategy as used here since the cost of the system would be excessive if used solely as a reminder (less than 5% responded this way). Given the low response rate achieved from electronic contact alone, together with the fact the majority of participants did not provide an electronic mailing address, we do not consider a purely electronic contact approach to questionnaire entry.

The marginal cost of surveying a population of size N with strategy 1 is

$$N \times (C_{\text{outward}} + p_1 \times C_{\text{inward}})$$

Where c_{outward} denotes the per-person cost of questionnaire printing and outward postage, c_{inward} is the per-person cost of returning and processing questionnaires, and p_1 is the proportion of those contacted who respond. In our trial, the cost of printing and the outward postage was £1.40 per questionnaire. Each returned questionnaire incurred postage (£0.38) and thereafter was imported into the database by scanning software, a proportion of which required additional checking for scanning errors and in some cases manual entry. Based on a four month sample of data entry, we estimate the cost of employing a clerical officer for this task to be £2.68 per questionnaire. We therefore estimate

the cost of postal questionnaires to be £3.06 per questionnaire returned, which for a 50% response rate gives a marginal cost of $£1.40 + 0.5 \times £3.06 = £2.93$ per mailout, or £5.86 per responder.

For strategy 2, the marginal cost is

$$C_{\text{system}} + N \times \{ (1 - p_{2e}) \times C_{\text{outward}} + p_{2p} \times C_{\text{inward}} \}$$

Where C_{system} is the cost of the system, p_{2e} is the proportion of N who respond electronically, p_{2p} is the proportion of N who respond by postal reminder, and C_{outward} and C_{inward} are as before. In our trial, we found an overall response rate of (approximately) 50% comprising 20% online questionnaires and 30% returned postal questionnaires. Assuming further that the costs C_{outward} and C_{inward} remain unchanged, the cost per person surveyed is $£1.40 \times (1 - 0.8) + (£2.68 + £0.38) \times 0.3 = £2.04$ (£4.08 per responder) for printing, postage and processing. The difference is therefore £0.89 per person contacted (£1.78 per responder) from strategy 1 before taking into account the cost of the online survey system.

In this survey, for which we had electronic contact details for over 8000 individuals, the system resulted in a cost saving. More generally, an online survey system becomes cost-saving when its development and maintenance cost is less than $N \times \{ p_{2e} \times C_{\text{outward}} + (p_1 - p_{2p}) \times C_{\text{inward}} \}$.

4. Discussion

4.1 Principal findings

We conducted a randomised trial to compare two strategies for collecting questionnaire data: a single e-mail which described the study and provided a link to the electronic database, and a posted questionnaire with a similarly worded covering letter. Participants were sent a reminder if no response had been received within 4-6 weeks, with the e-mail group contacted by post and the post group by e-mail. Although the eventual response rates were similar between the two randomised arms, the majority of responders did so via posted paper questionnaire. Based on this, we advise electronic data capture should not be used as the sole means by which to contact participants within randomised trials and cohort studies.

It is important to point out that whilst use of the online tool was disappointingly low, we were able to achieve a similar proportion of responses when following up with a posted reminder questionnaire, and at a reduced cost. The development of an online survey system requires an initial outlay but is offset by the reduction of costs incurred by postal charges and data entry. In our case, we modified a bespoke, web-based database system to allow participants to directly enter their data but recouped the cost of this through savings on postage and data entry. On this basis, we suggest electronic contact is a cost-effective method of contacting participants for larger scale studies, provided it is supplemented by conventional paper questionnaires. For clinical trials and population cohort studies however, it would appear that a wholly electronic approach cannot replace the more traditional paper based approach. Furthermore, the cost savings reported here will not be found on smaller studies if the upfront cost is not regained by savings on postal questionnaires.

4.2 Strengths and limitations

The conclusion that electronic contact reduces the response rate needs to be tempered on three counts. Firstly, our trial was undertaken in Yorkshire, UK, and other settings, particularly younger

populations, may have been more amenable to electronic communication. Our trial was also nested within a cohort study whose participants had previously responded to a postal questionnaire, and thereby arguably more likely to respond to paper-based questionnaires than the general population; whilst all had provided an e-mail address three years previously, it may not have been their preferred route of communication. Alternative types of communication – for instance an email augmented by telephone or SMS contact – may have produced a different response. We also note that around a fifth of participants were amenable to electronic contact, and those who responded by this medium did so rapidly. Electronic questionnaire completion therefore holds some potential benefit, and may be especially useful for surveys requiring a convenience sample in a short timeframe.

Although the randomisation should have resulted in approximately equal sized groups, the imbalance of 127 in favour of the electronic contact requires comment. The original imbalance of 10 was further increased by 14 more deaths and withdrawals in the postal group (45 vs 31), and in particular a second nested trial conducted within the first general practice which re-randomised 103 participants to a four-page questionnaire; these participants were also excluded.

We must also comment on the higher than anticipated number of participants who did not receive a reminder within the expected 4-6 weeks. These delays were due to having to delay mailouts whilst awaiting approval of payments to the mailing fulfilment house; having to delay printing of new versions of questionnaires and updates to the electronic questionnaire system whilst awaiting approval following changes to the consent wording; and resource issues caused by unexpected staff absence. Thus, of the original 5837 participants contacted only 3458 received their reminders as scheduled. Nevertheless, the findings among this subset closely matched those of the trial population as a whole.

4.3 The research in context: other experiences of electronic and paper questionnaire data capture

These findings mirror our experiences in general when using electronic data capture on other studies. The database used by the Sheffield CTRU was developed in-house and is a web-based system that allows remote data entry which can be adapted to allow participants to enter their data directly. To date, the unit has also used the system for this purpose on one randomised trial comparing two procedures for the treatment for haemorrhoids [14] and one observational study of pregnant females with suspected pulmonary embolism [15]. In both cases, participants were asked whether they could be contacted electronically, by post, or either. In the trial, the 33/370 participants who provided electronic contact details were contacted by email one year after their procedure, of whom nine (27%) completed the online questionnaire. For comparison, 69% of trial participants returned the self-completed questionnaire overall. In the observational study participants were contacted 30 days after their investigations with a postal questionnaire, with electronic reminders sent to those who had provided electronic contact details. In total 79 of the 324 participants were contacted electronically of whom 17 (22%) completed the questionnaire online and 20 (25%) completed by post. Overall 44% of the study participants returned the questionnaire.

Our experiences of electronic based surveys are in keeping with those reported in a systematic review of 29 electronic and paper based surveys undertaken between 1992 and 2006 [16]. Although there was considerable variation across the studies, the response rate to electronic based survey contacts were overall half of that found with paper questionnaires. The surveys were not limited to medical questionnaires, and the authors issue caution in the interpretation noting the changing nature of internet use. More recently, two small randomised trials of questionnaire response reached

conflicting results. Nota *et al.* reported similar response rates for electronic and paper questionnaires in a cohort of patients presenting to a hand and upper extremity department; interestingly, they found telephone contact to yield higher response rates [17]. By contrast, Palmen *et al.* found a far greater response rate for paper questionnaires sent to a cohort of patients following surgery for hallux valgus [6]. A third trial, surveying 533 women prior to mammography, was more similar to ours by virtue of having a postal reminder 10 days following initial contact [7]. Similar to our experience, they reported a substantial difference in response rates prior to reminder (73% paper v 18% electronic), but also a difference after the reminder (77% v 64%) plus higher data completeness in the electronic completion arm, both of which contradicted our findings.

Another strategy not considered by our trial is to offer the choice of either electronic or postal completion. A recent trial by Bray *et al.* studied a UK birth cohort aged 21 at the time of contact, with participants randomised to either an electronic contact or a postal contact offering a choice of online or postal questionnaires [18]. They reported response rates of 47% and 49% respectively with half of responders doing so electronically, all of which were substantially higher than ours for this age group; their use of five reminders comprising electronic, postal, social media and phone contact are likely to explain much of this difference. The authors found the postal/choice approach to be more expensive. More consistent with our findings is a non-randomised study of women's experiences of maternity care in the UK, in which contact was made by postal questionnaire with an option to complete online; only 8% of responders used the electronic route [19].

Naturally, some of the disadvantages of e-mail surveys also apply to postal surveys. Errors of coverage, sampling, measurement and non-response, together with problems of illiteracy, and non-deliverability may also impact on the representativeness of responders [20]. Previous work has also suggested that people with mental health conditions tend to open their mail less [21]; it is reasonable to speculate the same is also true for electronic mail. Nevertheless, the characteristics of individuals responding to an electronic-only survey has been repeatedly found to differ from the wider target population, particularly in regards to age [22,23] although counter-examples exist [19].

Finally, several authors have suggested that the answers provided can themselves be influenced by the method of contact. On the simplest level, this may represent the number of questions completed. We found high completion rates irrespective of the method of response, in direct contradiction to a previous study reporting greater data completeness among web-questionnaire respondents [24]. The same authors also provide a thoughtful reflection on how the quality (as well as quantity) of responses may depend upon the medium it is delivered, although reassuringly a systematic review of 46 studies and 233 patient reported outcome measures found paper and electronic completion to be equivalent [25]. This issue is a multifaceted one which we have not attempted to quantify.

4.4 Implications for researchers

The decision as to whether or not to use an online questionnaire will depend on numerous factors. Electronic data entry may be particularly amenable among participants that have expressed a preference for email contact, and in particular younger populations that are more likely to be internet users - although interestingly, the latter was not borne out by our data. Reassuringly, in this general population survey we found the overall response rate and case mix was similar regardless of whether first contact was made electronically or by post, meaning the decision may therefore be largely based on cost. For studies that entail a large mail out the financial benefits are obvious, but studies should be considered on a case by case basis: certainly, the costs and response rates reported herein will not apply to all research scenarios.

It is however important for researchers using electronic communication as a survey method to understand what factors determine whether an individual chooses to open or delete an e-mail. Electronic communication has been recommended for reminders as well as data capture [18,26], and qualitative research suggests that people delete e-mails if the subject line is of no interest to them or if they fail to recognise the name of the sender. In general, scientific e-mail surveys, even those which are anonymous, receive more favourable responses than commercial surveys [27]. As digital objects, e-mails lack physicality but they may have practical consequences, significance or relevance and, in that sense, can be considered 'material' [28,29]. Appearance and layout also matters: advertising on Google and Facebook have reportedly outperformed that of online news media, suggesting that the presentation of an online approach can affect its reception [30,31]. Future research should investigate how best to pilot e-mail and online surveys [32], specifically whether usability engineering and user experience methods may be able to increase the appeal of online and e-mail surveys through tailoring them to match the motivations and values of the target population.

5. Conclusions

Online questionnaire entry is viable and is less costly for larger studies, but should be supplemented with a postal reminder in order to achieve an acceptable response rate and a generalisable sample.

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Table legends

Table 1 Characteristics of the study population

Table 2 Response rates according to randomised group

Table 3 Method of response according to age, gender and socio-economic status

Table 4 Comparison of participants by randomised group, participants by response route, and the non-randomised health cohort

Table 5 Response rate for key questionnaire items

Figure legends

Figure 1 Participant flow

Figure 2 Proportion of questionnaires received by randomised group, timing and method of response

Web-only material

Appendix 1 – Copy of email and screenshots from survey system

Appendix 2 – Summary screen showing data completion

Appendix 3 - Point of entry rules applied to electronic questionnaire

Appendices

n.b. Appendices have been included for completeness. If included in the publication we suggest they be as web-only supplements.

Appendix A – copy of email and screenshots from survey system

Email Yorkshire Health Online <yorkshirehealthonline@sheffield.ac.uk>

12/02/2014

To: [REDACTED]

Dear [REDACTED]

Three years ago your GP sent you a Health Questionnaire. **You and 27,802 other people** in South Yorkshire and Derbyshire returned Health Questionnaires to us at the University of Sheffield. **Thank you!** Your information helps give us an up-to-date picture of the health and wellbeing of local people and helps us find the best treatments to prevent and treat illness in the future. We will send you a **Newsletter** with findings from all the Health Questionnaires local people send us.

Will you please **help** us again by filling in the attached Health Questionnaire?

https://survey.ctru.shef.ac.uk/?auth_token=pl5iFtuCj3M7T_b5UxPmaYPdN_2iX1_60pDUmNm9QgKs

This will take 10-20 minutes to complete.

If you have any questions, then please do contact us. You can withdraw your consent from this study at any time in the future. Thank you again for all your help with our research.

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About you

Your sex: Male Female

[Clear my answer](#)

Your date of birth: dd/mm/yyyy

Your height: Imperial ft. in

Your weight: Imperial st. lbs

Your waist measurement: Imperial in

With a flexible tape measure please measure the narrowest point between your hips and your ribs, usually just above the belly button.

Thinking about your own life and personal circumstances, how satisfied are you with your life as a whole?

Please indicate by selecting one option below:

[Clear my answer](#)

Completely Dissatisfied									Completely Satisfied	
0	1	2	3	4	5	6	7	8	9	10
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

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You and your health (I)

The following questions ask about your own health

By placing a tick in one box in each group below, please indicate which statements best describe your own health TODAY

Mobility Clear my answer	Please select one:
I have no problems in walking about	<input type="radio"/>
I have slight problems in walking about	<input type="radio"/>
I have moderate problems in walking about	<input type="radio"/>
I have severe problems in walking about	<input type="radio"/>
I am unable to walk about	<input type="radio"/>
Balifaire Clear my answer	Please select one:
I have no problems washing or dressing myself	<input type="radio"/>
I have slight problems washing or dressing myself	<input type="radio"/>
I have moderate problems washing or dressing myself	<input type="radio"/>
I have severe problems washing or dressing myself	<input type="radio"/>
I am unable to wash or dress myself	<input type="radio"/>
Usual Activities (e.g. work, survey, housework, family or leisure activities) Clear my answer	Please select one:
I have no problems doing my usual activities	<input type="radio"/>
I have slight problems doing my usual activities	<input type="radio"/>
I have moderate problems doing my usual activities	<input type="radio"/>
I have severe problems doing my usual activities	<input type="radio"/>
I am unable to do my usual activities	<input type="radio"/>
Pain / Discomfort Clear my answer	Please select one:
I have no pain or discomfort	<input type="radio"/>
I have slight pain or discomfort	<input type="radio"/>
I have moderate pain or discomfort	<input type="radio"/>
I have severe pain or discomfort	<input type="radio"/>
I have extreme pain or discomfort	<input type="radio"/>
Anxiety / Depression Clear my answer	Please select one:
I am not anxious or depressed	<input type="radio"/>
I am slightly anxious or depressed	<input type="radio"/>
I am moderately anxious or depressed	<input type="radio"/>
I am severely anxious or depressed	<input type="radio"/>
I am extremely anxious or depressed	<input type="radio"/>

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You and your health (II)

Do you have any long-standing illness, health problem, condition or disability?
Clear my answer

Yes No

If yes, please tick all that apply

<input type="checkbox"/> Tiredness / Fatigue	<input type="checkbox"/> High blood pressure
<input type="checkbox"/> Pain	<input type="checkbox"/> Heart disease
<input type="checkbox"/> Insomnia	<input type="checkbox"/> Osteoarthritis
<input type="checkbox"/> Anxiety / Nerves	<input type="checkbox"/> Stroke
<input type="checkbox"/> Depression	<input type="checkbox"/> Cancer
<input type="checkbox"/> Memory problems	<input type="checkbox"/> Other
<input type="checkbox"/> Diabetes	<input type="text" value="Please state..."/>
<input type="checkbox"/> Breathing problems e.g. chronic bronchitis, asthma or emphysema	

Overall, how bothersome has your long standing condition been in the last 2 weeks? Name the one or two that bother you the most here and then tick your response:
Clear my answer

Illness	Not at all	Slightly	Moderately	Very much	Extremely
(Example) Low back pain		<input checked="" type="radio"/>			
<input type="text"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<input type="text"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

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Your work and exercise

During the last WEEK how many hours did you spend on each of the following activities?
(Please answer, whether you are in employment or not)

	None	Some but less than 1 hour	At least 1 hour but less than 3 hours	3 hours or more
a Physioal exercise such as swimming, jogging, aerobics, football, tennis, gym workout etc. Clear my answer	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b Cycling, including cycling to work and during leisure time Clear my answer	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c Walking, including walking to work, shopping, for pleasure etc. Clear my answer	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

During the last 3 MONTHS, on how many days has your ill health prevented you from carrying out your:

Household tasks days

Leisure activities days

Paid work days

Please tell us the type and amount of physical activity involved in your work

[Clear my answer](#)

- a I am not in employment (e.g. retired, retired for health reasons, unemployed, full-time carer etc)
- b I spend most of my time at work sitting (such as in an office)
- c I spend most of time at work standing or walking. However, my work does not require much intense physical effort (e.g. shop assistant, hair dresser, security guard, childminder, etc)
- d My work involves definite physical effort including handling of heavy objects and use of tools (e.g. plumber, electrician, carpenter, cleaner, hospital nurse, gardener, postal delivery worker, etc)
- e My work involves vigorous physical activity including handling of very heavy objects (e.g. scaffolder, construction worker, refuse collector, etc)

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Your healthcare and medication

In the last 3 MONTHS, how many times have you visited the following:

Hospital	Times	Other carers	Times
Accident & Emergency (A&E)	<input type="text"/>	Counsellor	<input type="text"/>
Hospital - day case	<input type="text"/>	Care worker	<input type="text"/>
Hospital - outpatients	<input type="text"/>	Social worker	<input type="text"/>
Hospital - in-patients (how many nights)	<input type="text"/>	Health visitor	<input type="text"/>
Other healthcare workers		Community health champion	<input type="text"/>
GP	<input type="text"/>	Health trainer	<input type="text"/>
Nurse	<input type="text"/>	Alternative therapist	
Physiotherapist	<input type="text"/>	Acupuncturist	<input type="text"/>
Dietitian	<input type="text"/>	Chiropractor	<input type="text"/>
Midwife	<input type="text"/>	Herbalist	<input type="text"/>
Mental health worker	<input type="text"/>	Homeopath	<input type="text"/>
Psychotherapist	<input type="text"/>	Osteopath	<input type="text"/>
Dentist	<input type="text"/>	Other (Please describe)	
Chiropodist/Podiatrist	<input type="text"/>	<input type="text"/>	
Optician	<input type="text"/>	<input type="text"/>	

Do you buy any medications not prescribed by your doctor (e.g. vitamins and mineral supplements, dietary supplements, diet pills, herbal or homeopathic remedies)?
[Clear my answer](#)

Yes No

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Do you buy any medications not prescribed by your doctor (e.g. vitamins and mineral supplements, dietary supplements, diet pills, herbal or homeopathic remedies)?
[Clear my answer](#)

Yes No

If yes, please describe:

Name and strength of tablet, medicine, ointment, drops, inhaler or injection	What is this for?
<input type="text" value="(Example) Co-codamol 8mg/500mg tablets"/>	<input type="text" value="Joint pain"/>
+ Add another	

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[Next →](#)

Progress bar: About you | You and your health (0) | You and your health (0) | Your food and drink | Your work and exercise | Your healthcare and medication | You and others | **Consent form** | Summary

Consent form

Thank you for your answers. These will be combined with thousands of others. What we learn will help us understand how we can improve the health of people living in South Yorkshire.

May we contact you again?
[Clear my answer](#)

Yes No

May we look at your health records?
[Clear my answer](#)

Yes No

Note: If you tick 'Yes', then we will link your questionnaire answers to your health and healthcare records held by the Health and Social Care Information Centre and the Office for National Statistics. It is completely up to you whether you tick 'yes' or 'no'.

Please fill in your forename, surname and address

Name

Forename Surname

Address

Address 1

Address 2

Address 3

Town/City

County Postcode

Please fill in your preferred contact details below:

Phone (including dialling code) Mobile

Email

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Appendix B – summary screen showing data completion

<https://ctrn-survey1.demo2.epigenesys.org.uk/surveys/cohort2/summary>

Progress bar: About you | You and your health (i) | You and your health (ii) | Your food and drink | Your work and exercise | Your healthcare and medication | You and others | Consent form | **summary**

Summary

Please check the information you provided below - click on a section heading to view the responses in that section.
If you wish to modify any of your answers please click the section heading, then the question to go back to the form. Any **highlighted fields** have not been completed.

About you	4
You and your health (i)	0
You and your health (ii)	0
Your food and drink	0
Your work and exercise	0
Your healthcare and medication	1
You and others	0
Consent form	7

Reviewed

Once you submit you will not have the opportunity to update any of your answers

If you have any queries or require further information please contact:
Annette Haywood at SqHARR, University of Sheffield, FREEPOST - SF1314, Sheffield, S1 1AY.
Tel: 0114 222 0802 Email: sync@sheffield.ac.uk
© 2014 The University of Sheffield Built by epiGenesys



Appendix C – Point of entry rules applied to electronic questionnaire

Label	Min	Max TODAY -
Your date of birth	01/01/1900	16
Your height - ft	2	8
Your height - in	0	11
Your height - cm	100	220
Your weight - stone	4	35
Your weight - lbs	0	13
Your weight - kg	25	220
Your waist measurement - in	15	75
Your waist measurement - cm	35	170
How satisfied are you with your life as a whole? [Life satisfaction]	0	10
How many pieces of fruit [How many pieces of fruit, of any sort, do you eat on a typical day?]	0	50
How many portions of vegetables [How many portions of vegetables, excluding potatoes, do you eat on a typical day?]	0	50
Household tasks	0	92
Leisure activities	0	92
Paid work	0	92
Accident & Emergency (A&E)	0	99
Hospital - day case	0	99
Hospital - outpatients	0	99
Hospital - in-patients (how many nights)	0	99
GP	0	99
Nurse	0	99
Physiotherapist	0	99
Dietitian	0	99
Midwife	0	99
Mental health worker	0	99
Psychotherapist	0	99
Dentist	0	99
Chiropodist/Podiatrist	0	99
Optician	0	99
Counsellor	0	99
Care worker	0	99
Social worker	0	99
Health visitor	0	99
Community health champion	0	99
Health trainer	0	99
Acupuncturist	0	99
Chiropractor	0	99
Herbalist	0	99
Homeopath	0	99

Osteopath	0	99
How many hours of care have you received . . . [How many hours of care have you received over the past week?]	0	168
How many people live in your household?	0	15
How many children do you have (under 18) living with you?	0	10
If you are a carer . . . [If you are a carer (someone who provides support to family or friends who could not manage without this help) then how many hours have you spent caring for others over the past week?]	0	168

