SALDRU

Southern Africa Labour and Development Research Unit

Handwashing behaviour and habit formation in the household: evidence of spillovers from a pilot randomised evaluation in South Africa

Abigail Sellman, Justine Burns, and Brendan Maughan-Brown

Working Paper Series
Number 226, Version 1

About the Author(s):
Abigail Sellman, School of Economics University of Cape Town. Private Bag X3, Rondebosch, 7701, abigail.sellman@gmail.com - corresponding author.
Justine Burns: School of Economics, University of Cape Town, Private Bag, Rondebosch, 7701, justine.burns@uct.ac.za.
Brendan-Maughan-Brown: Southern Africa Labour and Development Research Unit, University of Cape Town, Private Bag X3, Rondebosch, 7701, brendan.maughanbrown@gmail.com.

Acknowledgements: We gratefully acknowledge funding provided by the Abdul Latif Jameel Poverty Action Lab (J-PAL) Incubation Fund.

Declaration of interest:
The authors have no actual or potential conflict of interest to declare.

Recommended citation
Sellman, A., Burns, J., Maughan-Brown, B., (2018). Handwashing behaviour and habit formation in the household: evidence of spillovers from a pilot randomised evaluation in South Africa. Cape Town: SALDRU, UCT. (SALDRU Working Paper Number 226).

ISBN: 978-1-928281-87-0

Handwashing behaviour and habit formation in the household: evidence of spillovers from a pilot randomised evaluation in South Africa

Abigail Sellman, Justine Burns, Brendan Maughan-Brown

Saldru Working Paper 226
University of Cape Town
May 2018

Abstract

Handwashing with soap at critical times is a simple and effective way to prevent the spread of communicable diseases, such as diarrhoea and acute respiratory infection, which are major causes of morbidity and mortality in the developing world. However, rates of handwashing remain low, and interventions which attempt to improve handwashing behaviours have largely been unsuccessful in practice. In 2014, we conducted a pilot randomised evaluation in poor urban community in Cape Town to measure the impacts of HOPE SOAP© – a translucent bar of soap with a toy inside of it, designed to make handwashing fun for children. In the pilot, 229 households were randomly assigned to receive four deliveries of HOPE SOAP© over a period of eight weeks. Analysis found that that HOPE SOAP© had positive impacts on children's handwashing behaviours and health outcomes. In this study, we expand upon the previous analysis, and examine the spillover effects – or indirect effects – that the intervention had on other members of children's households. Specifically, we employ OLS regression analysis to investigate the impacts of HOPE SOAP© on the handwashing behaviours of children's primary caregivers (based observation, where a snack was provided to caregivers and data were recorded on handwashing prior to preparing the snack), and on the health outcomes of all non-treated household members. Evidence shows that a child's assignment to HOPE SOAP© had a positive impact on the handwashing behaviour of their caregiver: the intervention increased the probability that a caregiver washed their hands before preparing a snack (at a second instance of observation) by 13 percentage points on average (p-value 0.17). Investigation of the causal mechanisms for this effect suggests that HOPE SOAP© affected caregiver behaviour both by disrupting existing poor-hygiene habits, and strengthening handwashing norms within households. Specifically, the intervention effect was larger for caregivers whose households had a lower cleanliness score at baseline (*b:* 0.19, p-value 0.12); suggesting that the intervention may have been effective at disrupting bad hygiene habits. Despite its positive effects on behaviour, HOPE SOAP© had no discernible short-term impacts on the health of individual household members. Nonetheless, the positive impact of HOPE SOAP© on caregiver handwashing behaviour suggests that the intervention's effects extend beyond improvements in outcomes for children; and indicate that HOPE SOAP© may be successful in inducing habitual handwashing behaviours which can persist in the long-run. Thus, a future large-scale randomised controlled trial is warranted to test this promising intervention.

1. Introduction

Communicable diseases are a leading cause of morbidity and mortality in the developing world today. The most common of these diseases include diarrhoea and acute respiratory infection (ARI), which are often transmitted as a result of inadequate sanitation and hygiene. More than one-third of deaths among children under the age of five each year globally are caused by diarrhoea and acute respiratory infection; and approximately 88% of diarrhoea-related deaths are attributable to poor sanitation and hygiene (World Bank 2005; Black, Morris, and Bryce 2003). Further, communicable diseases can also cause adults to miss work and be unable to complete simple day-to-day tasks, leading to a decline in productivity and loss of income (Rosen and Vincent 1999). In 2001 alone, diarrhoeal disease and acute respiratory infection accounted for 10% of all disability adjusted life years (DALYs) lost across the world (Lopez et al. 2006). Accordingly, population health and well-being are tightly linked with economic growth; and thus, promoting health through improving sanitation and hygiene is important to a country's economic development and overall prosperity (Bloom and Canning 2008).

Handwashing with soap at critical times, such as before preparing food or after defecation, disrupts the transmission path of a virus or bacteria, and is a simple and effective way to prevent the spread of diarrhoeal disease and acute respiratory infection (Luby et al. 2005; World Bank 2005; Briceño, Coville, and Martinez 2015). Handwashing with soap has been proven to decrease the incidence of diarrhoea in children by up to 48% (Cairncross et al. 2010; Taylor et al. 2015). Nonetheless, rates of handwashing remain low throughout the world. In developing countries, it is estimated that only between 3-34% of individuals routinely wash their hands with soap at critical times (Galiani et al. 2016). Moreover, the majority of programs and interventions which have attempted to increase handwashing practices through improving knowledge about the benefits of hand-hygiene have been unsuccessful in practice (Vindigni, Riley, and Jhung 2011). While such programs almost always lead to improvements in an individual's knowledge about proper handwashing techniques (Chase and Do 2012; Galiani et al. 2016; Briceño, Coville, and Martinez 2015; Biran et al. 2009; Cairncross et al. 2005), better knowledge rarely translates into improved handwashing behaviour (Chase and Do 2012; Briceño, Coville, and Martinez 2015; Biran et al. 2009).

This discrepancy, between knowledge and action, may exist because handwashing is a habitual behaviour, driven largely by automatic processes and contextual cues, rather than knowledge or beliefs (Marteau, Hollands, and Fletcher 2012; Neal et al. 2015). Habits are behaviours which are learned incrementally over time, and become automatic (rather than motivated) when repeated many times over (Neal et al. 2015; Aunger et al. 2010). Because handwashing occurs as part of a daily routine, it is repeated frequently enough to become habitual (Aunger et al. 2010; Curtis, Danquah, and Aunger 2009). Similarly, even when individuals do not engage in handwashing behaviours, they are still regularly presented with opportunities in which handwashing should take place – and therefore can form a habit of not handwashing. In addition to its repetitive nature, handwashing is a habitual behavior because it is largely driven by contextual cues such as the presence of soap, key occasions (i.e., defecation, food preparation), and social norms (Aunger et al. 2010; Curtis, Danquah, and Aunger 2009; Neal et al. 2015). Despite its habitual nature, habit is poorly addressed in the literature on handwashing behaviour change, and very few interventions which have attempted to improve handwashing practices actually target its automatic drivers (Neal et al. 2015).

In contrast, HOPE SOAP©[1], an innovative soap technology, is one intervention that aims to improve rates of handwashing by specifically leveraging insights into the habitual nature of the behaviour. HOPE SOAP© is a colourful and translucent bar of soap with a toy embedded at its centre, sized for children's hands, and designed to make handwashing fun and engaging for children. HOPE SOAP© encourages handwashing habit formation in children in a few ways. First, the toy placed in

[1] HOPE SOAP© is copyright of Young & Rubicam: http://www.yr.com/

the centre of HOPE SOAP© makes handwashing fun and goal-oriented (Burns, Maughan-Brown, and Mouzinho 2017). In this way, HOPE SOAP© implicitly encourages children to engage in handwashing behaviour; and may be able to disrupt children's existing poor-hygiene habits. Second, because children must wash their hands many times in order to obtain the toy at the soap's centre, HOPE SOAP© ensures that the newly incited handwashing behaviour is repeated consistently. By encouraging repetition, HOPE SOAP© may be able to instil a new habit of handwashing in children: leading to behaviour change that persists (or sticks) over time.

Evidence from a pilot randomised controlled trial, conducted in 2014 among 229 households in a poor-urban community outside of Cape Town, South Africa, showed that HOPE SOAP© had positive (albeit underpowered) impacts on children's handwashing behaviours and health outcomes (Burns, Maughan-Brown, and Mouzinho 2017). Specifically, conditional on poor baseline handwashing behaviour, children who received HOPE SOAP© were reported to be significantly more likely to wash their hands after using the toilet than children who received an equivalent bar of soap without a toy in its centre (i.e., control soap). HOPE SOAP© children were also reported to be more likely than control children to use soap when washing their hands. Moreover, children in the HOPE SOAP© group were more likely (by 10 percentage points) to be observed washing their hands unprompted before eating a snack on two occasions (p-value 0.26). The pilot study also indicated that children who received HOPE SOAP© displayed fewer symptoms of illness than children who received control soap (Burns, Maughan-Brown, and Mouzinho 2017).

While a positive intervention effect was found on children, the previous analysis did not account for the potential spillover effects from HOPE SOAP© – or the additional indirect impacts (positive or negative) that the intervention may have had on non-targeted individuals in children's households. Hence, the full impact of HOPE SOAP© on the entire study population remains unknown. The importance of measuring spillovers is increasingly being recognized in the development and health economics literature as critical to evaluating the overarching impact of an intervention, assessing its cost-effectiveness, and its policy relevance (Benjamin-Chung et al. 2017). Nevertheless, to date, only one evaluation has explicitly examined spillovers in the context of a handwashing intervention (Benjamin-Chung et al. 2018).

Accordingly, this study investigates the indirect effects that the HOPE SOAP© intervention had on the handwashing behaviours and health outcomes of other individuals residing in children's households. Spillovers from the HOPE SOAP© intervention may have occurred through a variety of channels. Firstly, because the health of treated children improved due to HOPE SOAP©, all household members may have benefited from positive health externalities because of the reduction in overall disease transmission rates within households. Second, HOPE SOAP© may have led to interaction spillover effects if, for instance, children who received HOPE SOAP© shared their soap with family members: indirectly influencing non-treated members' health and handwashing behaviours. And finally, behavioural spillovers may have occurred when HOPE SOAP© improved children's handwashing behaviours; thereby inducing other household members to shift their behaviours as well, or changing the overall social norms around handwashing within treated households.

Results from the following analysis of the intervention's spillovers indicate that a child's assignment to HOPE SOAP© treatment had a positive impact on the handwashing behaviour of their caregiver. Specifically, a child's assignment to HOPE SOAP© improved the probability that a caregiver washed their hands before preparing a snack (at a second point of observation) by approximately 13 percentage points on average (p-value 0.17), compared to caregivers whose children only received control soap. A further exploration of the causal mechanisms for this improvement suggests that HOPE SOAP© may have affected caregiver behaviour by disrupting caregivers' existing poor-hygiene habits and strengthening household social norms around handwashing behavior. However, despite the positive effect on caregivers' handwashing behaviors, HOPE SOAP© did not improve health outcomes for other individuals in treated children's households. Nevertheless, the positive impact of HOPE SOAP© on caregiver handwashing behaviour suggests that the intervention's effect extended beyond children; and combined with the positive

effects found on children, indicates that HOPE SOAP© may have been successful in inducing habitual handwashing behaviour throughout the household. Thus, HOPE SOAP© could prove a useful way to decrease diarrhoeal disease and acute respiratory infection for individuals living in developing countries, and further research on this promising intervention is warranted.

2. Experimental design

To evaluate the impact of HOPE SOAP©, we conducted a pilot randomised controlled trial in 2014 in the poor urban community of Delft. Delft is located approximately 34 kilometres outside of Cape Town, in the Western Province of South Africa, and is an area which typically faces a high burden of diarrhoeal disease (Western Cape Government 2011). The randomised evaluation was completed in partnership with the Foundation for Community Work (FCW), an early childhood development (ECD) non-profit organization. The Foundation for Community Work runs the Family-in-Focus (FIF) programme in Delft and multiple other communities in the Western Province. Households who participate in the Family-in-Focus programme receive bi-weekly visits from trained community health workers. During these visits, health workers engage with children's caregivers on a variety of ECD issues, including health and hygiene, and help to facilitate child-caregiver interactions (Burns, Maughan-Brown, and Mouzinho 2017). At the start of the implementation period, households in Delft were served by 13 FCW community workers.

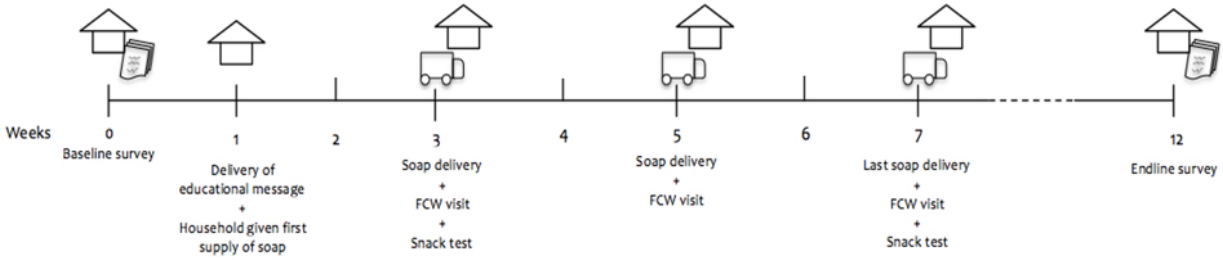
To be eligible for participation in the randomised evaluation of HOPE SOAP©, households in the FIF programme must have met the following three criteria: (1) at least one child in the programme was aged 3 to 9 years old; (2) caregivers were interested in continued Family-in-Focus programme participation; and (3) children were not enrolled in any other ECD programme (Burns, Maughan-Brown, and Mouzinho 2017). In total, 203 households (defined prior to the study as residential addresses of individuals enrolled in the FIF programme) were eligible for study enrolment. In 22 cases, multiple caregivers (each with their own children enrolled in the FCW program) resided in the same physical structure; although these caregivers defined their individual family units as separate households. Accordingly, we defined study households as the 229 separate family units rather than the 203 distinct physical structures. Households were randomly assigned (with an allocation fraction of 1:1) to one of two experimental groups: a HOPE SOAP© treatment group, or a control group. Children in the control group received a bar of soap almost identical to HOPE SOAP© (i.e., transparent, colourful, and with the same dimensions), except with a toy alongside, rather than inside, the soap. Randomisation was clustered at the household level, so that all children within a particular household were assigned to the same intervention group. Randomisation was stratified by household size, the gender and age ratio among eligible children, and the number of caregivers (i.e., separate family groups/households) in the dwelling. Randomisation was conducted using the statistical software package Stata 14 (Stata Corporation LP, College Station, TX).

The evaluation was integrated into the Family-in-Focus programme for all households for a period of 12-weeks – from September to December 2014 (see Figure 1); and during this time, children in both the treatment and control groups received soap and their typical Family-in-Focus programming. At the first experimental session in September (Week 1), children in all households received health and hygiene information from their community health worker along with a bar of soap. Both HOPE SOAP© and the control soap were packaged in brown paper parcels clearly labelled with children's names to (1) enable children to feel a sense of ownership over the soap, and (2) to ensure that community workers were blind to treatment assignment when they delivered the soap and provided the first FIF education lesson.

After community workers delivered soap and education at the first session (Week 1), households in both experimental groups continued to receive soap from an independent research team, bi-weekly over an 8-week period (at Weeks 3, 5, 7). Thus, children received four bars of soap

in total throughout the evaluation period. Soap deliveries were typically made in the same week as Family-in-Focus visits from health workers.

Figure 1: Evaluation timeline



Data were collected by external enumerators, through baseline and endline questionnaires given to primary caregivers prior to the first soap distribution (Week 0), and again five weeks after the final soap distribution (Week 12). Data on handwashing behavior were collected through self-reported indicators and by direct observation. Including questions on self-reported behaviour is standard procedure in research on handwashing; however, self-reported measures are likely to provide biased accounts of actual handwashing behaviour. Evidence shows that individuals are typically two or three times less likely to wash their hands in practice (based upon observed measures), than what they self-report (Galiani 2012; Orsola-Vidal and Yusuf 2011; Vindigni, Riley, and Jhung 2011). Accordingly, we also collected a measure of observed handwashing behaviour. At two of the regular Family-in-Focus visits occurring during the experimental period, FCW health workers conducted so-called 'snack-tests', in which they observed the handwashing behaviours of children and their caregivers. During the snack-tests, health workers provided households with a snack of crackers and jam, and recorded (1) if caregivers washed their hands prior to preparing the snack, and (2) if children washed their hands unprompted prior to eating the snack.

One potential limitation of our observed measure of behavior was that community workers may have been aware of households' treatment status (i.e., whether they received control soap or HOPE SOAP©). Therefore, they could have interacted with households differently and/or recorded the handwashing behaviours of households differently depending on households' assigned experimental groups. However, we explicitly designed the evaluation to minimize the potential for this bias. Firstly, an independent research team distributed soap to children, rather than the community workers themselves. Second, community workers were under the impression that the goal of the study was to examine the impact of overall soap provision, rather than the difference between HOPE SOAP© and control soap. And, finally, randomisation was stratified at the community worker level, ensuring that each community worker serviced households in both the control and treatment groups.

3. Sample characteristics

At baseline, a total of 229 households and caregivers, 288 children, and 1,288 additional household members (including caregivers, but not children who received soap) formed our sample. Households were relatively large in size (7.7 members on average); and 82% of the heads-of-household were Coloured (a common and socially acceptable racial classification in South Africa, which describes an individual of mixed-race ancestry). Additionally, households generally had low incomes: over 40% reported a total household income of less than R2,000 per month. The vast majority of the caregivers

were female (approximately 97%), and the average age among caregivers was 36 years old. On average, the highest level of education completed by primary caregivers was Grade 10, and only 18% of caregivers reported that they had worked for income in the past two weeks. Of the 1,288 other household members in the sample, 22% were also children between 2 and 10 years old, and 7% were infants 0-1 years old.

In terms of hygiene infrastructure, 79% of households had piped water inside their dwelling; and 87% of households reported having a toilet inside their home. Particularly relevant to the context of handwashing, 44% of households reported limiting their water use, and 18% limited handwashing for members of their households. Significantly more households in the control group had piped water inside their dwelling as compared to treatment households (85% versus 73%); and control households were also less likely to limit their water use (38.5% versus 50%). At the time of baseline data collection, survey enumerators also observed whether or not soap was visible in the household, and recorded household cleanliness on a scale between 1 and 10 (where 1 represented a very dirty household and 10 represented a very clean household). These two observed indicators provide insights into households' general hygiene and handwashing habits (Ram 2010; Chase and Do 2010). At baseline, soap was observed in 61% of households; and the average cleanliness score of households was 5.67 out of 10. Households in the treatment group scored slightly higher on the cleanliness measure (6.0) than those in the control (5.2). See Appendices 1 through 3 for tables detailing full baseline descriptive statistics.

Moreover, prior to the intervention, caregivers in the sample had good handwashing practices and a relatively high knowledge of proper handwashing techniques (see Appendix 4 for a table detailing indicators and response choices). At baseline, 86% of caregivers in the sample stated that they always wash their hands before preparing food; 83% stated that they always wash their hands before eating; and 88% stated that they always use soap to wash their hands. This high level of self-reported behaviour is consistent with literature which suggests individuals are likely to report correct handwashing behaviour (Vindigni, Riley, and Jhung 2011). Additionally, on a knowledge index between 0 (no knowledge) and 11 (perfect knowledge), 52% of caregivers scored a nine or higher; and only 6.5% scored a 4 or lower. Importantly, there were no significant differences in the self-reported handwashing behaviours or knowledge of proper handwashing techniques between caregivers in the control and treatment groups.

Table 1: Caregiver baseline handwashing behaviours and knowledge

VARIABLE	(1) Full Mean/SD	(2) Control Mean/SD	(3) Treatment Mean/SD
Wash before food prep [0-3]	2.808 (0.50)	2.802 (0.51)	2.813 (0.50)
Wash before eating [0-3]	2.860 (0.51)	2.886 (0.47)	2.837 (0.55)
Use soap to wash hands [0-2]	1.803 (0.56)	1.840 (0.50)	1.772 (0.61)
Handwashing score [0-6]	5.336 (1.37)	5.413 (1.26)	5.270 (1.46)
Handwashing knowledge [0-11]	8.483 (2.48)	8.574 (2.50)	8.407 (2.47)
Observations	229	106	123

T-test for significance: *p<0.1 **p<0.05 ***p<0.01

Furthermore, at baseline caregivers reported on the health status and prevalence of illness-symptoms for all 1,288 non-treated members of their households. Overall, caregivers reported that 49% of household members' health was characterized as good; 36.5% of individuals' health was very good or excellent; and only 14% of individuals' health was poor or fair. However, there were differences in health status between individuals in the study groups: household members in the treatment group were reported to have significantly better health than those in the control group. Additionally, at baseline, very few individuals in the sample population had experienced any symptom of illness in the previous two weeks. Fewer than 3% of individuals experienced nausea or diarrhoea symptoms in the two weeks prior to baseline. Instances of flu were more prevalent: around 16% of household members had experienced some flu symptoms (such as cough or fever) in the two weeks to prior to the baseline survey. Only 6% of household members in the sample were too sick to take part in their normal day-to-day activities in the previous two weeks; and those that were too sick missed an average number of 5.8 days of their normal activities. Despite the fact that sample population seemed relatively healthy at baseline, it should be noted that because caregivers reported on the health of all household members, the indicators used to assess health may be relatively blunt measures of actual health.

Table 2: Baseline individual health

VARIABLE	(1) Full Mean/SD	(2) Control Mean/SD	(3) Treatment Mean/SD
Health status [1-5]	3.475 (1.09)	3.415 (1.09)	3.528* (1.09)
Too sick for normal day-to-day activities	0.065 (0.25)	0.066 (0.25)	0.064 (0.25)
Number of sick days	0.353 (1.78)	0.367 (1.87)	0.341 (1.71)
Diarrhoea	0.021 (0.14)	0.024 (0.15)	0.018 (0.13)
Flu	0.157 (0.36)	0.163 (0.37)	0.151 (0.36)
Nausea	0.029 (0.17)	0.035 (0.18)	0.025 (0.15)
Observations	1284	601	683

T-test for significance: *p<0.1 **p<0.05 ***p<0.01

Importantly, there were few significant differences at baseline between the demographic characteristics of households, caregivers, and individuals in the treatment and control groups: indicating successful randomisation. Thus, baseline equivalence provides confidence that the control group was a valid counterfactual for measuring the impacts of HOPE SOAP© on the treatment group (Gertler et al. 2011; Glennerster and Takavarasha 2013); and our analysis adjusts for the few factors which were significantly different between the two groups at baseline. These factors include: whether a household limited their water use; if a household had piped water in their dwelling; the observed cleanliness of a household; and an individual's reported health status.

4. Estimation strategy

To identify the indirect effects that a child's assignment to HOPE SOAP© treatment had on the handwashing behaviours and health of household members not targeted with the intervention, we use the following Ordinary Least Squares (OLS) regression model:

(1) $$y_i = a + bT + dX + e_i$$

In Equation 1, the dependent variable y_i is the outcome of interest (either health or behaviour) for each individual caregiver or household member *i*; *d* is a vector of coefficients on the group of control variables *X*; *a* is some constant; and e_i is the unobserved error term for each individual observation *i*. Covariates in *X* include the demographic characteristics unbalanced between the control and treatment groups at baseline. The parameter of interest is *b*: the coefficient on the dummy independent variable *T;* where *T* is equal to 1 if individual *i* comes from a household where a child was assigned to the treatment group, and equal to 0 if individual *i* comes from a household assigned to the control group. Recall that children in households assigned to the control group also received a similar bar of soap, and thus *b* should be interpreted as the effect of HOPE SOAP© relative to this soap. All standard errors in the following results are clustered at the community health worker level in order to account for potential error correlation between households served by the same community worker, and to correct for heteroskedasticity.

In many cases in the analysis below, the outcomes of interest, y_i, are binary variables (e.g., observed handwashing behaviours are equal to 1 if a caregiver washed their hands at the snack-test, and equal to 0 if they did not). OLS regression models are meant to estimate linear and continuous variables, and thus, there may be statistical concerns regarding our use of linear estimation with binary dependent variables. Nevertheless, liner models typically provide good approximations of the partial effects of a treatment on binary dependent variables; and OLS regression models also provide results which are simpler to interpret than binary models (Wooldridge 2010). Accordingly, for our primary analysis, we use the *b* coefficients from the OLS models to interpret the effects of treatment assignment. However, to account for statistical concerns, we conduct a sensitivity analysis using logistic (logit) and probability unit (probit) regression models and present these results in the Appendix (tables 5 and 7).

Furthermore, although we collected data on caregivers' self-reported handwashing behaviors at endline, these data may provide poor approximations of caregivers' actual behaviors. At endline, 82% of caregivers reported that they both always wash their hands before preparing food, and always use soap to wash their hands. However, in practice, only 36.4% of caregivers were observed to wash their hands before both snack-tests (a 45 ppt discrepancy). Additionally, the correlation coefficient between an index of self-reported handwashing behaviour and observed handwashing at both snack tests was -0.18; suggesting that caregivers who reported good handwashing behaviours were actually slightly less likely to wash their hands at the snack-tests. Accordingly, the analysis below does not use self-reported measures of handwashing to assess the impact of HOPE SOAP© on caregivers' handwashing behaviors, but rather, solely uses observational data from the two snack-tests.

5. Results

<u>Result 1:</u> HOPE SOAP© improves caregiver handwashing behaviour at snack-test 2

The means of caregivers' observed handwashing behaviours at the snack-tests are given in Table 3. As shown, there was no significant difference in the proportion of caregivers who washed their hands at the first snack-test between caregivers in the treatment and control groups. However, by snack-test 2, the difference in behaviours was significant (p-value 0.07): 52% of caregivers in the treatment group were observed washing their hands, compared to only 37% of caregivers in the control group. Further, the percentage of caregivers who washed their hands declined over time (from snack-test 1 to snack-test 2) for caregivers in both experimental groups; but the rate of decline was much greater for caregivers in the control group than for those in the treatment. The number of caregivers in the control group who washed their hands decreased by 27 percentage points from snack-test 1 to snack-test 2, while handwashing only declined by 5 percentage points over time for caregivers in the treatment group (see Figure 2).

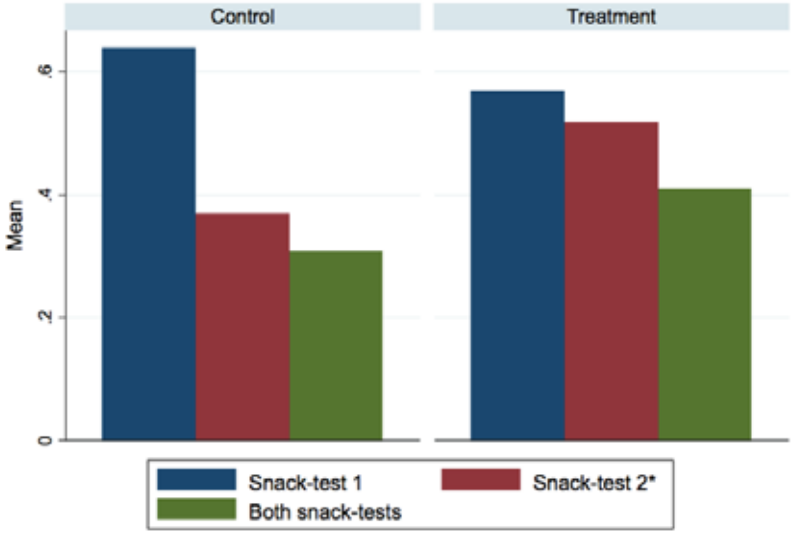
Table 3: Means of caregiver handwashing behaviour[2]

VARIABLE	(1) Control Mean/SD	(2) Treatment Mean/SD	(3) Glass's D Diff./CI-95%
Snack-test 1	0.639	0.569	0.144
	(0.48)	(0.50)	[-0.14, 0.43]
Snack-test 2	0.369	0.518*	-0.306
	(0.49)	(0.50)	[-0.63,0.02]
Both snack-tests	0.308	0.410	-0.219
	(0.47)	(0.49)	[-0.54,0.10]
Observations	83	102	229

Rank-sum tests for significance: *p<0.1 **p<0.05 ***p<0.01

[2] A rank-sum test for significance is used because it does not assume that the variable of interest is normally distributed. In an effort to present results which are comparable across studies, standardized effect sizes (the standard difference between the two groups' means) are displayed in column (3) and calculated using Glass's Delta: $\frac{\mu_{treatment} - \mu_{control}}{\sigma_{control}}$

Figure 2: Observed handwashing at snack-tests



* = Significant difference, p-value 0.07.

Multivariable OLS regression analysis (Table 4), also indicates that HOPE SOAP© had a positive effect on caregiver behaviour at snack-test 2. Holding all else equal, we estimate that a child's assignment to HOPE SOAP© treatment led to a 13 percentage point increase (p-value 0.17), on average, in the probability that a caregiver washed their hands at snack-test 2 (column 2). Additionally, HOPE SOAP© treatment led to a 7 percentage point increase (p-value 0.42) in the probability of handwashing at both snack-tests (column 4); but was associated with a 10 percentage point decrease (p-value 0.23) in the probability of handwashing at snack-test 1 (column 1).

The negative coefficient on the treatment at snack-test 1 could imply that the intervention had an initial adverse effect on behaviour. Perhaps more likely, however, is that observed handwashing at snack-test 1 reflects baseline differences in actual handwashing behaviour between caregivers in the control and treatment groups. This possibility would be consistent with the baseline finding that three of the self-reported handwashing measures were slightly lower in the treatment than control group (Table 1), though these differences were not significant. Based on the assumption that handwashing behaviour at snack-test 1 may act as a proxy for baseline handwashing behaviour, and because past actions are a key determinant of current habitual behaviours (Ouellette and Wood 1998; Neal et al. 2012; Aunger et al. 2010), in an additional model which regresses the treatment on behaviour at snack-test 2 (column 3), we include a measure of handwashing at snack-test 1 as a control variable. Including this control variable increases the intervention effect slightly: a child's assignment to HOPE SOAP© treatment led to a 14 percentage point increase (p-value 0.08), on average, in the probability that a caregiver washed their hands.

Table 4: Effect of HOPE SOAP© on caregiver handwashing behaviour (OLS results)

	(1) Wash hands at snack-test 1	(2) Wash hands at snack-test 2	(3) Wash hands at snack-test 2	(4) Wash hands at both tests
Treatment	-0.10	0.13	0.14*	0.07
	(0.08)	(0.09)	(0.08)	(0.08)
	0.23	0.17	0.08	0.42
Snack-test 1			0.43***	
			(0.08)	
			0.00	
Piped water in house	0.08	-0.08	-0.10	-0.04
	(0.11)	(0.11)	(0.09)	(0.10)
	0.44	0.46	0.24	0.74
Baseline cleanliness score	0.07***	0.07***	0.03	0.08***
	(0.01)	(0.02)	(0.02)	(0.02)
	0.00	0.00	0.14	0.00
Limits water use	0.07	0.09	0.08	0.12
	(0.08)	(0.09)	(0.08)	(0.09)
	0.37	0.33	0.30	0.19
Constant	0.18	0.02	-0.00	-0.14
	(0.13)	(0.13)	(0.12)	(0.11)
	0.17	0.87	0.97	0.21
Observations	146	119	119	119
R-squared	0.13	0.14	0.29	0.19

Standard errors in parentheses, followed by p-values. *** p<0.01, ** p<0.05, * p<0.1

<u>Result 2:</u> HOPE SOAP© may have improved caregiver handwashing behaviour through behavioural spillovers

The finding in Result 1 indicates that HOPE SOAP© had a spillover effect on handwashing behaviour. The intervention's indirect effect could have occurred through a variety of channels. One possibility is that the effect was caused by behavioural spillovers: or effects on a non-treated population which arise as a result of an intervention changing the behaviors of individuals in close proximity to one another, or changing the social norms surrounding a particular behaviour within a treated context (Angelucci and Di Maro 2010). In this way, by improving the handwashing practices of children in the treatment group, HOPE SOAP© could have implicitly encouraged caregivers to wash their hands as well, and/or shifted overall household social norms towards better handwashing practices.

To explore whether caregivers handwashing behaviours were determined, in-part, by their children's behaviours, we assess the correlation between behaviours at each snack-test (Table 5). The behaviours of caregivers and children in both treatment and control households were highly correlated (0.80) at snack-test 1. However, at snack-test 2, the correlation coefficient between caregiver and child behaviour was much stronger for treatment group than the control group. At snack-test 2, the correlation between the behaviours of individuals in the treatment group was 0.90, while only 0.62 for individuals in the control group. This could indicate that HOPE SOAP©'s effects transfer from children to caregivers through a behavioral spillover; perhaps by generating a stronger norm around handwashing behaviour as compared control soap.

Table 5: Correlation coefficients between child and caregiver behaviour

		Child		
	Caregiver	Snack-test 1	Snack-test 2	Both
(1) Full sample n = 145	Snack-test 1	0.802		
	Snack-test 2		0.785	
	Both			0.718
(2) Treatment n = 82	Snack-test 1	0.800		
	Snack-test 2		0.903	
	Both			0.829
(3) Control n = 62	Snack-test 1	0.813		
	Snack-test 2		0.626	
	Both			0.562

Furthermore, if HOPE SOAP© affected caregivers' behaviours by way of behavioural spillovers from children, child behaviour would be a mediator for caregiver behaviour – or a mechanism by which the treatment indirectly influenced the outcome (Baron and Kenny 1986; Kazdin 2007). Accordingly, we conduct a mediation analysis to examine the influence of child behavior on caregiver behaviour. If child behaviour mediated HOPE SOAP©'s effect on caregiver behaviour, the following three statistical criteria would be true (Baron and Kenny 1986; Kazdin 2007). First, HOPE SOAP© would have influenced caregiver behaviour. Result 1 above provides evidence of this: assignment to HOPE SOAP© improved caregiver behaviour at snack-test 2. Second, HOPE SOAP© would have influenced child behaviour. Evidence for this was provided in the previous study which examined the effects of HOPE SOAP© on children's handwashing behaviours (Burns, Maughan-Brown, and Mouzinho 2017). And third, when child behaviour is added to the regression of HOPE SOAP© on caregiver behaviour, (a) the coefficient on child behaviour must be statistically significant, and (b) including the child level variable must reduce the effect of the treatment on caregiver behaviour. Table 6 presents results from mediation analyses, which regress the treatment and child behaviour on caregiver handwashing behaviour at each snack-test. For all snack-test outcomes, the coefficients on child behaviour (columns 2, 4, 5, 7) are statistically significant (p-value < 0.1). At snack-test 2 specifically, the coefficient on the treatment declines from 0.13 in the original model (column 3) to 0.05 (column 4); and for both snack-tests, the coefficient on the treatment declines from 0.07 in the original model (column 6) to 0.02 (column 7). Thus, child behaviour meets all the statistical conditions to be considered a mediator for HOPE SOAP© 's effect on caregiver behaviour at snack-test two and both snack-tests: reinforcing the idea that HOPE SOAP© may affect caregivers through behavioral spillovers from children.

Table 6: Child behaviour as a mediator for HOPE SOAP©'s effect on caregiver behaviour (OLS results)

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Wash hands at snack-test 1		Wash hands at snack-test 2			Wash hands at both	
Treatment	-0.10	-0.15***	0.13	0.05	0.05	0.07	0.02
	(0.08)	(0.05)	(0.09)	(0.05)	(0.05)	(0.08)	(0.07)
	0.23	0.01	0.17	0.32	0.32	0.42	0.77
Child wash at ST-1		0.75***					
		(0.06)					
		0.00					
Child wash at ST-2				0.75***	0.77***		
				(0.05)	(0.06)		
				0.00	0.00		
Snack-test 1					-0.02		
					(0.05)		
					0.65		
Child wash at both							0.65***
							(0.07)
							0.00
Observations	146	143	119	118	118	118	116
R-squared	0.13	0.61	0.14	0.65	0.65	0.19	0.55
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses, followed by p-values. *** p<0.01, ** p<0.05, * p<0.1

A second possible channel which may have caused spillovers from HOPE SOAP© is if children shared their intervention soap with caregivers – therefore increasing caregivers' access to soap, and inducing them to wash their hands. However, only 2% of caregivers in the study reported that their child shared his/her soap with anyone else in the household, thus limiting the potential for this form of spillover. It is also possible that the FCW programme and its health and hygiene lesson (presented by community workers at the first FIF visit) had a direct impact on caregivers' handwashing behaviors. To measure caregiver engagement in the FCW programme, in addition to conducting the snack-tests, at each FIF visit throughout the intervention period, health workers also recorded a caregiver's level of interest in that week's lesson. Interestingly, health workers recorded that caregivers whose children received HOPE SOAP© had a greater level of interest in the FIF lessons on average, compared to control caregivers (control mean = 7.67, treatment mean = 7.90, p-value 0.53). As health workers serviced households in both the treatment and control groups, this difference is unlikely to have arisen because of differences in health worker disposition, or simply due to bias in health worker reporting.

Further, because caregivers in the treatment group had a greater interest in the Family-in-Focus programme than those in the control group, it may be that interest was also a latent mechanism through which HOPE SOAP© influenced caregiver behaviour. To test for this possibility, we conduct an analysis which includes interest as an additional independent variable in the OLS regressions of the treatment on behaviour, and find that: (1) caregiver interest did not influence caregiver behaviour at the snack-tests (coefficients on the interest variables are small in size), and (2) interest did not mediate HOPE SOAP©'s effect on behaviour (treatment coefficients in the new models are relatively the same size as the models where interest is excluded). The same is true for caregivers' knowledge about proper handwashing techniques and critical times. Caregivers' knowledge about handwashing did rise slightly from baseline to endline for caregivers in both

experimental groups: by 5% on average on a composite index of 0-11 (with no significant differences between the baseline or endline knowledge scores for caregivers in the treatment versus control groups). However, knowledge did not influence or mediate the treatment's effect on caregiver behaviour. See Appendix 6 for a table with the OLS results which include interest and knowledge as additional covariates. In sum, these additional models illustrate that a child's assignment to HOPE SOAP© treatment had an effect on caregiver behaviour which was not mediated by improvements in their knowledge of handwashing techniques, nor by their interest in the Family-in-Focus programme.

Result 3: HOPE SOAP© may have differential effects on behaviour, conditional on baseline cleanliness

The results given in Table 4 indicate that baseline household cleanliness was a significant determinant of caregiver handwashing behaviour. We expect this positive relationship, *a priori*, because observations of a household's environment typically provide valuable information about its general hygiene behaviours (Ram, 2010). Accordingly, as cleanliness may provide insight into a household's overall hygiene habits, it is possible that HOPE SOAP© may have had differential effects on caregiver behaviour depending on baseline household cleanliness (i.e., baseline hygiene habits). Specifically, because HOPE SOAP© was designed to disrupt bad hygiene habits of not washing hands with soap, the intervention may have been more effective for households who had poorer baseline cleanliness.

Baseline household cleanliness was recorded by survey enumerators on a scale from 1-10, where 10 represented the cleanest possible score, and 1 was the dirtiest. On average, households scored a 5.67 out of 10, and the median score was 5. Hence, we create a binary indicator variable to identify relatively clean households (1 = households who scored 6 or higher), versus relatively unclean households (0 = households who scored 5 or lower). To assess whether the effect of HOPE SOAP© varied depending on baseline household cleanliness, we include an interaction term ('baseline cleanliness indicator' X 'treatment assignment') in our OLS regression analyses (Table 7). When the interaction term is included in the models, its coefficients are all large and negative; indicating that the effect of the treatment on caregiver behaviour was less when households were clean at baseline, than when they were dirty at baseline. Additionally, for snack-test 2 and both snack-tests (columns 4 and 7), while the marginal effects of the treatment on caregiver behaviour were small among cleaner households **(**-0.02 for snack-test 2; -0.06 for both snack-tests), the treatment effects on caregivers from less clean households were large and borderline statistically significant (snack-test 2 $b = 0.19$, p-value 0.12; both snack-tests $b = 0.16$, p-value 0.12). These findings indicate that the intervention had differential effects on caregivers depending on baseline household cleanliness: HOPE SOAP© was more effective at improving the behaviour of caregivers with poor household cleanliness at baseline (i.e., poor existing hygiene habits).

Table 7: Differential effects of HOPE SOAP© by baseline household cleanliness (OLS results)

VARIABLE	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Wash hands at snack-test 1		Wash hands at snack-test 2			Wash hands at both snack-tests	
Treatment	-0.10	0.01	0.13	0.19	0.15	0.07	0.16
	(0.08)	(0.12)	(0.09)	(0.12)	(0.10)	(0.08)	(0.10)
	0.23	0.92	0.17	0.12	0.15	0.42	0.12
Clean household		0.35***		0.35***	0.19		0.36***
		(0.10)		(0.12)	(0.13)		(0.11)
		0.00		0.00	0.14		0.00
Clean*Treatment		-0.23		-0.21	-0.11		-0.22
		(0.15)		(0.17)	(0.16)		(0.15)
		0.12		0.20	0.49		0.15
Snack-test 1					0.38***		
					(0.08)		
					0.00		
Baseline cleanliness	0.07***		0.07***			0.08***	
	(0.01)		(0.02)			(0.02)	
	0.00		0.00			0.00	
Observations	146	171	119	139	139	119	139
R-squared	0.13	0.09	0.14	0.10	0.23	0.19	0.13
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses, followed by p-values. *** p<0.01, ** p<0.05, * p<0.1

Result 4: A child's assignment to HOPE SOAP© has no effect on household member health

In addition to indirectly affecting caregivers' handwashing behaviours, we expect that assignment to HOPE SOAP© treatment may have had spillover effects on household members' health. Spillovers from treated children to other household members could have occurred as a result of interaction spillovers or externalities. For instance, interaction effects could have led to improved health for household members if a treated child shared his/her soap with other individuals, thereby increasing individuals' access to soap. However, recall that only 2% of caregivers reported that their child shared soap with anyone else in the household; and it is thus highly unlikely that interaction spillovers occurred. More probable is the possibility that positive externalities (or the positive health effects which occur when overall disease transmission is lowered in a treated context) led to effects for household member health – since the initial analysis of child outcomes found that HOPE SOAP© improved the health of treated children (Angelucci and Di Maro 2010, Burns, Maughan-Brown, Mouzinho 2017).

We use OLS regressions to estimate the impacts of HOPE SOAP© on the health outcomes of all additional members of children's household (including sample caregivers, but not treated children). Despite the theoretical possibility of positive externalities, the results in Table 8 demonstrate that a child's assignment to HOPE SOAP© did not lead to any particularly large, or statistically significant, effects on household member health. Additionally, the signs of the treatment coefficients given in Table 8 are inconsistent across the scope of all health outcomes, and thus no inference can be made as to whether or not HOPE SOAP© had an overall positive or negative effect on individual health.

Table 8: Effect of HOPE SOAP© on household member health (OLS results)

VARIABLES	(1) Health status	(2) Diarrhoea	(3) Flu	(4) Nausea	(5) Any symptom	(6) Too sick for actv	(7) Num sick days
Treatment	0.03	-0.00	0.04	-0.01	0.03	-0.02	-0.09
	(0.13)	(0.01)	(0.03)	(0.01)	(0.04)	(0.02)	(0.13)
	0.82	0.84	0.18	0.29	0.38	0.30	0.47
Piped water in house	0.23	-0.00	-0.09*	-0.01	-0.06	0.01	0.16
	(0.17)	(0.02)	(0.05)	(0.02)	(0.06)	(0.03)	(0.12)
	0.17	0.94	0.10	0.52	0.25	0.85	0.16
Baseline cleanliness	-0.07***	-0.00	0.00	0.00	0.00	0.00	-0.02
	(0.03)	(0.00)	(0.01)	(0.00)	(0.01)	(0.01)	(0.03)
	0.01	0.93	0.71	0.58	0.96	0.44	0.54
Limits water use	0.02	0.00	0.03	-0.00	0.02	0.00	0.01
	(0.13)	(0.02)	(0.03)	(0.01)	(0.04)	(0.02)	(0.12)
	0.90	0.77	0.33	0.82	0.66	0.94	0.93
Baseline health	-0.22***	-0.00	-0.01	-0.01	-0.01	-0.02**	-0.15**
	(0.05)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.06)
	0.00	0.95	0.33	0.32	0.31	0.02	0.02
Constant	3.55***	0.04	0.16***	0.05*	0.20***	0.15***	0.82***
	(0.28)	(0.02)	(0.06)	(0.02)	(0.07)	(0.05)	(0.27)
	0.00	0.12	0.01	0.07	0.00	0.01	0.00
Observations	772	773	773	773	774	774	772
R-squared	0.07	0.00	0.02	0.00	0.01	0.01	0.01

Standard errors in parentheses, followed by p-values. *** p<0.01, ** p<0.05, * p<0.1

6. Discussion

The finding that HOPE SOAP© improved caregivers' handwashing behaviours is promising; and in conjunction with evidence of the intervention's positive effect on child behaviour, provides reason to believe that HOPE SOAP© may cause habitual handwashing behaviour which could persist in the long-run. The evidence is favourable for a variety of reasons. First, not only did HOPE SOAP© lead to a higher probability that a caregiver washed their hands at snack-test 2, but it led to a significantly higher probability when controlling for behaviour at snack-test 1. Literature on habit formation suggests that past actions are a key determinant in predicting current habitual behaviours (Ouellette and Wood 1998). While this was the case in our study (washing at snack-test 1 led to a 43ppt increase in the probability of washing at snack-test 2), HOPE SOAP© was also successful in inducing handwashing at snack-test 2 when controlling for caregivers' prior-behaviours. Moreover, HOPE SOAP© had a larger impact on behaviour when caregivers' households were unclean at baseline (i.e., caregivers with poor hygiene habits). These two findings – that HOPE SOAP© had a stronger effect on caregivers whose households were dirty at baseline, and significantly improved handwashing when controlling for behaviour at snack-test 1 – allude to the fact that HOPE SOAP© was able to disrupt caregivers' existing poor-hygiene habits. The ability of an intervention to disrupt existing habits is key to creating lasting change in habitual behaviours (Neal et al. 2015); and thus, this evidence is certainly encouraging.

Furthermore, one reason many previous interventions have been ineffective at changing

handwashing behaviours was because they concentrated on updating individuals' beliefs and intentions rather than attempting to leverage automatic processes, despite the fact that habitual behaviours are not driven by cognitive thought (Marteau, Hollands, and Fletcher 2012). This is why education on the benefits of handwashing with soap often fails to create lasting behaviour change, even when it can successfully improve knowledge (Marteau, Hollands, and Fletcher 2012; Curtis, Danquah, and Aunger 2009). Hence, knowledge is rarely a predictor of actual handwashing behaviour (Biran et al. 2009; Vindigni, Riley, and Jhung 2011). We also find this to be also true in the context of HOPE SOAP©: caregivers' behaviours were not determined by their knowledge of proper handwashing practices; nor did knowledge affect the degree of influence that the treatment had on behaviour.

As it did not influence caregiver behaviour by improving knowledge, HOPE SOAP© must have affected handwashing behaviour through some alternative causal pathway. One way our analysis above explores this is by interrogating the relationship between caregiver and child behaviour. The positive and strong correlation between caregivers and children's handwashing behaviours suggests that handwashing behaviour was consistent within households. As such, handwashing behaviour in the evaluation households may be considered a social norm. As social norms often serve as the contextual cues which induce habitual behaviours, a positive correlation between child and caregiver behaviour should be expected (Curtis, Danquah, and Aunger 2009). Accordingly, the finding that the correlation between child and caregiver behaviour at snack-test 2 was much stronger in households where children received HOPE SOAP© is encouraging: it is possible that one way HOPE SOAP© improved caregiver behaviour was by strengthening the social norms surrounding handwashing within treated households. Interventions which can alter the underlying processes which lead to habitual behaviours (such as norms) are typically more successful in creating lasting change (Neal et al. 2015; Marteau, Hollands, and Fletcher 2012). Thus, HOPE SOAP© again shows the promise of being able to generate sustained handwashing behaviour change.

Moreover, because HOPE SOAP© was specifically designed to target children, its impacts on caregiver behaviour can be considered a spillover. While our analysis certainly suggests that HOPE SOAP© influenced caregiver behaviour through a behavioral spillover from treated children, conclusions made based on the mediation analysis should be handled with caution. First, because data were collected on caregiver and child behaviours at the same point in time, there is no way to discern if child behaviour changed prior to caregiver behaviour and not vice versa (Kazdin 2007). And second, because although results from the child level analysis show that HOPE SOAP© led to improvements in children's handwashing behaviour, the small sample size and lack of statistical significance in these results means that this cannot be unequivocally be proven true. Nevertheless, only one study which examines spillovers from a handwashing promotion program currently exists in the development and health economics literature; and this study focuses on health rather than behavioural outcomes (Benjamin-Chung et al. 2018). Accordingly, our evaluation of HOPE SOAP© makes a significant contribution to the literature. From a policy perspective, the fact that HOPE SOAP© may influence handwashing behaviour through behavioural spillovers is imperative. If the effects of a handwashing encouragement intervention can transfer throughout a population, policy-makers can design better, and more cost-effective, programs with this in mind. From a research perspective, evidence of the existence of positive behavioural spillovers from a handwashing intervention suggests that handwashing studies which fail to account for spillovers in design and analysis could underestimate the true impacts a program.

Lastly, although the randomised design of this impact evaluation, in addition to many of the statistical precautions taken during analysis, ensure experimental and analytical rigor, several caveats and limitations should be noted. First, the pilot nature of the evaluation limited its total sample size. Because of its relatively small sample size, this evaluation may be underpowered to pick up statistically significant results; and it is difficult to discern if many of the statistically insignificant findings presented above exist because of a true lack of effect. A 13% attrition rate further reduced the sample's size; although 13% attrition is relatively standard throughout the

impact evaluation literature (see Cameron, Shah, and Olivia 2013; Galiani, Gertler, and Orsola-Vidal 2012; Banerjee et al. 2007). In total, 31 of the 229 households enrolled in the evaluation were absent at endline, and there was no evidence of differential attrition between households in the treatment and control groups. In addition to limiting sample size, the evaluation's pilot nature restricted the number of intervention arms in the experimental design. As such, the evaluation contained no pure control group, and inference can only be made on the effect of HOPE SOAP© compared to a group which also received soap and Family-in-Focus programming. Accordingly, our results provide little insight into the effects of the intervention as a whole (soap + programme enrolment); and no conclusions can be made on how HOPE SOAP© impacted individuals who did not also receive health and hygiene programming. While this aspect of the design is a limitation in some respects, it also gives this study a distinct advantage over impact evaluations which have examined the effects of large handwashing package interventions (including soap, education, etc.). Evaluations of comprehensive interventions are less useful from a policy perspective, because entire package interventions may be too expensive and too logistically challenging to deliver in practice (Zwane and Kremer 2007). In this way, our evaluation contributes to the existing literature by explicitly testing HOPE SOAP© (which could be more easily delivered) against an alternative soap product.

Furthermore, the pilot nature of the study limited the time period in which the experiment occurred to three months. Previous evaluations have shown that handwashing promotion programs have often been successful in creating short-term positive improvements in behaviour, but not long-term impacts (i.e., individuals often relapse into past poor-handwashing habits over time) (Neal et al. 2015; Vindigni, Riley, and Jhung 2011; Chase and Do 2010). Accordingly, the outcomes observed within our experiment's 3-month time frame may not provide accurate estimates of the intervention's effects on caregivers' handwashing behaviours in the long-run. To overcome this shortcoming, future research should include longer-term follow ups with treated households to measure if the intervention's impacts on handwashing behaviour are, in fact, sustained in the long-run. Nonetheless, the fact that HOPE SOAP© caused handwashing behaviour to be upheld from snack-test 1 to snack-test 2 for caregivers in the treatment group is quite promising, as it demonstrates sustained handwashing over a short period of time; and suggests that HOPE SOAP© may be able to generate behaviour change that sticks.

The evaluation's relatively short time period may have also limited our ability to correctly detect the intervention's health impacts. Previous evaluations of handwashing interventions which have found improvements to health outcomes have typically only observed these impacts in the long-term – with no short-term effects found (Luby et al. 2005). Again, future research should attempt to include longer-term follow up surveys in order to measure the health impacts of HOPE SOAP© over time. Our inability to observe any health impacts from HOPE SOAP© could also be due to the fact that the sample population was generally healthy. At both baseline and endline, caregivers reported that very few individuals in their households actually had any symptoms of illness. This small absolute number of individuals with poor health outcomes means that the data lacks variation; and it is harder to tease out if any treatment effects did occur. Additionally, although it is possible that the intervention could have had positive effects on caregiver health (because the intervention improved caregiver handwashing behavior), the total number of caregivers in the sample who reported any symptoms of illness was also very low. For instance, only 8 caregivers reported having nausea in the two weeks prior to endline data collection (3 in the control group, 5 in the treatment group). Moreover, caregiver handwashing behaviour was not associated with better reported health outcomes, but rather the opposite: the correlation coefficients between caregiver handwashing behaviour and health outcomes actually suggest that handwashing was correlated with more reported symptoms of illness. Accordingly, it may be that handwashing was not a significant determinant of health in the context of this evaluation. As such, other more influential determinants, such as community-wide sanitation and hygiene problems (open defecation, poor water quality, etc.), may have diluted the impacts of the intervention and/or weakened the ability of our analysis to detect any treatment effects (Andres et al. 2014; Briceño, Coville, and Martinez

2015). Goodness-of-fit statistical tests completed for our models which examine household member health also signal that the models' specifications were unable to properly predict household member health outcomes (refer to Table 8): low R-squareds suggest that only between 0 and 7% of the variations in outcomes are able to be attributed to the models' specifications.

A final empirical reason which could explain the non-discernible differences in the health outcomes of individual household members is the finding that in 44% of households where children received HOPE SOAP©, children broke open or destroyed the soap to obtain the toy inside (i.e., children 'cheated'). As such, in households where a treated-child cheated, control group children may actually have had more access to the intervention soap. Evidence from an OLS regression does show that when children cheated to obtain the toy, individuals in HOPE SOAP© households experienced significantly more flu symptoms than in control households (b_T = 0.07, SE = 0.04, p-value 0.09). Conversely, when treated children did not cheat, household members experienced significantly less nausea symptoms than those in the control (b_T = -0.02, SE = 0.01, p-value 0.07). The finding that many children did not use the soap as envisioned may mean that the provision of normal soap could actually be a more effective way to improve health outcomes than HOPE SOAP©. Nevertheless, if the intervention is successful in strengthening household norms around handwashing in the treatment group, HOPE SOAP© could prove to be a better way to improve health in the long-term regardless of whether or not a child cheats – and future research is needed disentangle these conflicting effects.

7. Conclusion

In conclusion, the analysis offered in this paper illustrates that a child's assignment to HOPE SOAP© treatment had positive impacts on the handwashing behaviour of their caregiver. By disrupting existing poor-hygiene habits and strengthening handwashing norms within households, HOPE SOAP© improved caregiver handwashing behaviour; and has the potential to create habitual behaviour change which may be sustained in the long-run. Additionally, evidence indicates that the effect of HOPE SOAP© on caregiver handwashing behaviour may have occurred through spillovers from treated children. This finding reveals the potential for behavioural spillovers to transpire as a result of handwashing interventions: serving as a consideration for policy makers and practitioners when developing effective handwashing interventions, and a call for more research into spillovers in handwashing behaviour. Despite its positive influence on caregiver handwashing behaviour, HOPE SOAP© did not lead any impacts on the health of individual members of treated households. While this finding may seem discouraging at first, there are many statistical and experimental reasons why no effects were detected. As such, this result should rather be thought of as a lesson for future researchers when considering how to better design experiments to measure the impacts of handwashing on health. Nevertheless, although HOPE SOAP©'s positive effect on handwashing behaviour did not lead to any health impacts in the short term, because it was successful at inducing a habit of handwashing behaviour, in the long-run it may prove a valuable tool to decrease diarrhoeal disease and ARI: two major causes of child mortality in the developing world.

References

Andres, Luis A., Bertha Briceno, Claire Chase, and Juan A. Echenique. 2014. "Sanitation and Externalities: Evidence from Early Childhood Health in Rural India."

Angelucci, Manuela, and Vincenzo Di Maro. 2010. "Program Evaluation and Spillover Effects." Inter-American Development Bank.

Aunger, Robert, Wolf-Peter Schmidt, Ashish Ranpura, Yolande Coombes, Peninnah Mukiri Maina, Carol Nkatha Matiko, and Valerie Curtis. 2010. "Three Kinds of Psychological Determinants for Hand-Washing Behaviour in Kenya." *Social Science & Medicine* 70 (3): 383–91.

Baron, Reuben M., and David A. Kenny. 1986. "The Moderator–mediator Variable Distinction in Social Psychological Research: Conceptual, Strategic, and Statistical Considerations." *Journal of Personality and Social Psychology* 51 (6): 1173.

Benjamin-Chung, Jade, Jaynal Abedin, David Berger, Ashley Clark, Veronica Jimenez, Eugene Konagaya, Diana Tran, et al. 2017. "Spillover Effects on Health Outcomes in Low- and Middle-Income Countries: A Systematic Review." International Journal of Epidemiology 46 (4):1251–76.

Benjamin-Chung, Jade, Nuhu Amin, Ayse Ercumen, Benjamin F. Arnold, Alan E. Hubbard, Leanne Unicomb, Mahbubur Rahman, Stephen P. Luby, and John M. Colford. 2018. "A Randomized Controlled Trial to Measure Spillover Effects of a Combined Water, Sanitation, and Handwashing Intervention in Rural Bangladesh." *American Journal of Epidemiology: Accepted Manuscript*.

Biran, Adam, Wolf-Peter Schmidt, Richard Wright, Therese Jones, M Seshadri, Pradeep Isaac, N. A. Nathan, et al. 2009. "The Effect of a Soap Promotion and Hygiene Education Campaign on Handwashing Behaviour in Rural India: A Cluster Randomised Trial: The Effect of a Soap Promotion and Hygiene Education Campaign on Handwashing Behaviour in Rural India." *Tropical Medicine & International Health* 14 (10): 1303–14.

Black, Robert E., Saul S. Morris, and Jennifer Bryce. 2003. "Where and Why Are 10 Million Children Dying Every Year?" *Lancet (London, England)* 361 (9376): 2226–34.

Briceño, Bertha, Aidan Coville, and Sebastian Martinez. 2015. "Promoting Handwashing and Sanitation: Evidence from a Large-Scale Randomized Trial in Rural Tanzania." Policy Reserach Working Paper 7164. Washington D.C.: The World Bank.

Burns, Justine, Brendan Maughan-Brown, and Âurea Mouzinho. 2017. "Washing with Hope: Evidence from a Hand-Washing Pilot Study among Children in South Africa." A Southern African Labour and Development Unit Working Paper Number 199. SALDRU, University of Cape Town.

Cairncross, Sandy, Caroline Hunt, Sophie Boisson, Kristof Bostoen, Val Curtis, Isaac CH Fung, and Wolf-Peter Schmidt. 2010. "Water, Sanitation and Hygiene for the Prevention of Diarrhoea." *International Journal of Epidemiology* 39 (suppl_1): i193–205.

Chase, Claire, and Quy-Toan Do. 2010. "Scaling Up Handwashing Behavior: Findings from the Impact Evaluation Baseline Survey in Vietnam." Water and Sanitation Program at the World Bank. https://www.wsp.org/sites/wsp.org/files/publications/WSP_VietnamBaselineReport_HWWS.pdf.

Claire Chase, and Quy-Toan Do. 2012. "Handwashing Behavior Change at Scale: Evidence from a Randomized Evaluation in Vietnam." World Bank Policy Research Working Paper 6207. Washington D.C.: The World Bank.

Curtis, Valerie A., Lisa O. Danquah, and Robert V. Aunger. 2009. "Planned, Motivated and Habitual Hygiene Behaviour: An Eleven Country Review." *Health Education Research* 24 (4): 655–73.

Galiani, Sebastian, Paul Gertler, Nicolas Ajzenman, and Alexandra Orsola-Vidal. 2016. "Promoting Handwashing Behavior: The Effects of Large-Scale Community and School-Level Interventions." *Health Economics* 25 (12): 1545–59.

Galiani, Sebastian Gertler, Paul Orsola-Vidal, Alexandra. 2012. *Promoting Handwashing Behavior in Peru: The Effect of Large-Scale Mass-Media and Community Level Interventions*. Policy Research Working Papers. The World Bank.

Gertler, Paul, Sebastian Martinez, Patrick Premand, Laura B. Rawlings, and Christel M.J. Vermeersch. 2011. *Impact Evaluation in Practice*. Washington D.C.: The World Bank.

Glennerster, Rachel, and Kudzai Takavarasha. 2013. *Running Randomized Evaluations: A Practical Guide*. Princetion, New Jersey: Princeton University Press.

Kazdin, Alan E. 2007. "Mediators and Mechanisms of Change in Psychotherapy Research." *Annual Review of Clinical Psychology* 3 (1): 1–27.

Luby, Stephen P., Mubina Agboatwalla, Daniel R. Feikin, John Painter, Ward Billhimer, Arshad Altaf, and Robert M. Hoekstra. 2005. "Effect of Handwashing on Child Health: A Randomised Controlled Trial." *Lancet (London, England)* 366 (9481): 225–33.

Marteau, Theresa M., Gareth J. Hollands, and Paul C. Fletcher. 2012. "Changing Human Behavior to Prevent Disease: The Importance of Targeting Automatic Processes." *Science (New York, N.Y.)* 337 (6101): 1492–95.

Neal, David T., Wendy Wood, Jennifer S. Labrecque, and Phillippa Lally. 2012. "How Do Habits Guide Behavior? Perceived and Actual Triggers of Habits in Daily Life." *Journal of Experimental Social Psychology* 48 (2): 492–98.

Neal, David, Jelena Vujcic, Orlando Hernandez, and Wendy Wood. 2015. "The Science of Habit: Creating Disruptive and Sticky Behavior Change in Handwashing Behavior." Washington D.C.: USAID/WASHplus Project.

Orsola-Vidal, Alexandra, and Ahmad Yusuf. 2011. "Scaling Up Handwashing Behavior: Findings from the Impact Evaluation Baseline Survey in Senegal." Water and Sanitation Program at the World Bank.

Ouellette, Judith A., and Wendy Wood. 1998. "Habit and Intention in Everyday Life: The Multiple Processes by Which Past Behavior Predicts Future Behavior." *Psychological Bulletin* 124 (1): 54–74.

Rosen, Sydney, and Jeffrey R. Vincent. 1999. *Household Water Resources and Rural Productivity in Sub-Saharan Africa: A Review of the Evidence*. Vol. 673. Harvard Institute for International Development, Harvard University Cambridge, MA.

Taylor, Dawn L., Tanya M. Kahawita, Sandy Cairncross, and Jeroen H. J. Ensink. 2015. "The Impact of Water, Sanitation and Hygiene Interventions to Control Cholera: A Systematic Review." *PLOS ONE* 10 (8): e0135676.

Vindigni, Stephen M., Patricia L. Riley, and Michael Jhung. 2011. "Systematic Review: Handwashing Behaviour in Low- to Middle-Income Countries: Outcome Measures and Behaviour Maintenance." *Tropical Medicine & International Health: TM & IH* 16 (4): 466–77.

Western Cape Government. 2011. "Diarrhoeal Disease Season." Western Cape Government - News and Speeches. December 28, 2011. https://www.westerncape.gov.za/news/diarrhoeal-disease-season-0.

World Bank. 2005. "The Handwashing Handbook: A Guide for Developing a Hygiene Promotion Program to Increase Handwashing with Soap." 32302. The World Bank.

Zwane, Alix Peterson, and Michael Kremer. 2007. "What Works in Fighting Diarrheal Diseases in Developing Countries? A Critical Review." Working Paper No. 140. Harvard University: Center for International Development.

Appendix 1: Household descriptive statistics

VARIABLE	(1) Full Mean/SD	(2) Control Mean/SD	(3) Treatment Mean/SD
Coloured head of household	0.828	0.827	0.829
	(0.38)	(0.38)	(0.38)
Head of household matriculated	0.135	0.133	0.137
	(0.34)	(0.34)	(0.35)
Asset score[Ñ]	9.157	9.186	9.132
	(3.15)	(3.23)	(3.10)
Income below 2000	0.407	0.396	0.416
	(0.49)	(0.49)	(0.50)
Piped water in home	0.785	0.848	0.732**
	(0.41)	(0.36)	(0.44)
Toilet in home	0.872	0.904	0.844
	(0.34)	(0.30)	(0.36)
Household limits water use	0.444	0.385	0.500*
	(0.50)	(0.49)	(0.50)
Soap present[†]	0.606	0.660	0.558
	(0.49)	(0.48)	(0.50)
Soap always available	0.717	0.705	0.727
	(0.45)	(0.46)	(0.45)
Household limits handwashing	0.180	0.190	0.171
	(0.38)	(0.39)	(0.38)
Household cleanliness[†] [1-10]	5.677	5.270	6.029**
	(2.42)	(2.46)	(2.35)
Observations	229	106	123

*p<0.1 **p<0.05 ***p<0.01

[Ñ] Composite score of 20 household assets

[†] Variable observed by external enumerators

Appendix 2: Caregiver descriptive statistics

VARIABLE	(1) Full Mean/SD	(2) Control Mean/SD	(3) Treatment Mean/SD
Age	35.780	35.272	36.217
	(11.38)	(11.20)	(11.56)
Male	0.027	0.010	0.042
	(0.16)	(0.10)	(0.20)
Highest grade completed	10.295	10.277	10.311
	(2.09)	(2.20)	(2.00)
Worked for income in past week	0.182	0.149	0.210
	(0.39)	(0.36)	(0.41)
Enrolled in FCW for +4 mo.	0.622	0.667	0.583
	(0.49)	(0.47)	(0.50)
Received hygiene info in past 3 mo.	0.605	0.653	0.563
	(0.49)	(0.48)	(0.50)
Completed a FCW hygiene module	0.353	0.411	0.304
	(0.48)	(0.49)	(0.46)
Observations	229	106	123

*p<0.1 **p<0.05 ***p<0.01

Appendix 3: Individual descriptive statistics

VARIABLE	(1) Full Mean/SD	(2) Control Mean/SD	(3) Treatment Mean/SD
Household size	7.724	7.700	7.745
	(2.84)	(2.84)	(2.85)
Age	25.086	25.136	25.043
	(17.82)	(18.05)	(17.64)
Male	0.450	0.457	0.444
	(0.50)	(0.50)	(0.50)
Highest grade completed, if adult 18+	10.115	10.258	10.000
	(2.78)	(2.60)	(2.91)
Worked in past week, if adult 18+	0.389	0.362	0.412
	(0.49)	(0.48)	(0.49)
Received social grant	0.511	0.493	0.526
	(0.50)	(0.50)	(0.50)
Child age 2-10	0.224	0.237	0.212
	(0.42)	(0.43)	(0.41)
Observations	1284	601	683

*p<0.1 **p<0.05 ***p<0.01

Appendix 4: Survey questions and response choices

Caregiver Handwashing Behavior

Variable	*Survey Question*	*Instrument type*	*Response type*
Handwash before food prep	How often do you…Wash hands before preparing food	Self-reported by primary caregiver at baseline and endline	Categorical [Always, Most of the time, Some of the time, None of the time]
Handwash before eating	How often do you…Wash hands before eating	-	-
Handwashing with soap	How often do you use soap for the following activities…To wash your hands	-	-
Handwash at snack-tests	Did …'s caregiver wash hands before handling food?	Observed by FCW worker at each FIF visit	Dummy variable, equal to 1 if yes

Household Member Health

Variable	*Survey Question*	*Instrument type*	*Response type*
Health status	How is the health of … at present? Would you say it is poor, fair, good very good, or excellent?	Reported by primary caregiver at baseline and endline	Categorical [Poor, Fair, Good, Very good, or Excellent]
Diarrhea	In the last 2 weeks, did … have any diarrhea?	-	Dummy variable, equal to 1 if yes
Flu	In the last 2 weeks, did … have any flu symptoms (e.g. fever, coughing, sore throat, headache)?	-	-
Nausea	In the last 2 weeks, did…experience any nausea or vomiting?	-	-
Too sick for activities	In the last 2 weeks was … ever too sick or too ill to carry out his or her normal activities (e.g. play, go to school, work)?	-	-
Number of sick days	How many days in the last 2 weeks was … too sick or too ill to carry out his or her normal activities?	-	Discrete number

Appendix 5: Effect of HOPE SOAP© on caregiver handwashing behaviour (OLS/Logit/Probit results)

VARIABLES	(1) OLS	(2) Logit	(3) Logit APE	(4) Probit	(5) Probit APE
Snack-test 1					
Treatment	-0.10	-0.50	-0.10	-0.31	-0.10
	(0.08)	(0.41)	(0.08)	(0.25)	(0.08)
	0.23	0.23	0.22	0.21	0.20
R^2 / Hosmer-Lemeshow pval	0.13	0.23		0.25	
Observations	146	146	146	146	146
Controls	Yes	Yes	Yes	Yes	Yes
Snack-test 2					
Treatment	0.13	0.58	0.12	0.37	0.12
	(0.09)	(0.42)	(0.08)	(0.26)	(0.08)
	0.17	0.17	0.16	0.15	0.15
R^2 / Hosmer-Lemeshow pval	0.14	0.20		0.68	
Observations	119	119	119	119	119
Controls	Yes	Yes	Yes	Yes	Yes
Snack-test 2					
Treatment	0.14*	0.78*	0.13*	0.46*	0.14*
	(0.08)	(0.44)	(0.07)	(0.26)	(0.07)
	0.08	0.08	0.07	0.08	0.07
Snack-test 1	0.43***	2.13***	0.37***	1.26***	0.38***
	(0.08)	(0.48)	(0.05)	(0.28)	(0.06)
	0.00	0.00	0.00	0.00	0.00
R^2 / Hosmer-Lemeshow pval	0.29	0.75		0.87	
Observations	119	119	119	119	119
Controls	Yes	Yes	Yes	Yes	Yes
Both snack-tests					
Treatment	0.07	0.34	0.06	0.23	0.07
	(0.08)	(0.43)	(0.08)	(0.26)	(0.08)
	0.42	0.43	0.43	0.38	0.37
R^2 / Hosmer-Lemeshow pval	0.19	0.04		0.04	
Observations	119	119	119	119	119
Controls	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses, followed by pvalues
*** p<0.01, ** p<0.05, * p<0.1

Appendix 6: Effect of HOPE SOAP© on caregiver handwashing behaviour – with interest and knowledge included as covariates

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Snack-test 1		Snack-test 2				Both snack-tests	
Treatment	-0.11	-0.09	0.14	0.13	0.21**	0.14*	0.10	0.07
	(0.09)	(0.08)	(0.11)	(0.09)	(0.09)	(0.08)	(0.10)	(0.09)
	0.23	0.27	0.19	0.17	0.02	0.08	0.32	0.42
Interest	0.01		0.00		-0.00		-0.01	
	(0.02)		(0.02)		(0.02)		(0.02)	
	0.64		0.95		0.85		0.63	
Knowledge		0.02		0.00		-0.01		0.02
		(0.02)		(0.02)		(0.02)		(0.02)
		0.28		0.90		0.48		0.41
Snack-test 1					0.55***	0.44***		
					(0.09)	(0.08)		
					0.00	0.00		
Observations	99	145	95	119	89	119	95	119
R-squared	0.24	0.14	0.09	0.14	0.30	0.29	0.16	0.19
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses, followed by pvalues. *** p<0.01, ** p<0.05, * p<0.1

Appendix 7: Effect of HOPE SOAP© on household member health (OLS/Logit/Probit results)

VARIABLE	(1) OLS	(2) Logit	(3) Logit APE	(4) Probit	(5) Probit APE
Diarrhoea					
Treatment	-0.00	-0.08	-0.00	-0.04	-0.00
	(0.01)	(0.43)	(0.01)	(0.19)	(0.01)
	0.84	0.84	0.84	0.84	0.84
R^2 / Hosmer-Lemeshow pval	0.00				
Observations	773	773	773	773	773
Controls	Yes	Yes	Yes	Yes	Yes
Flu					
Treatment	0.04	0.50	0.04	0.26	0.04
	(0.03)	(0.36)	(0.03)	(0.18)	(0.03)
	0.18	0.17	0.18	0.16	0.16
R^2 / Hosmer-Lemeshow pval	0.02				
Observations	773	773	773	773	773
Controls	Yes	Yes	Yes	Yes	Yes
Nausea					
Treatment	-0.01	-0.52	-0.01	-0.23	-0.01
	(0.01)	(0.50)	(0.01)	(0.20)	(0.01)
	0.29	0.30	0.34	0.25	0.28
R^2 / Hosmer-Lemeshow pval	0.00	0.00		0.00	
Observations	773	773	773	773	773
Controls	Yes	Yes	Yes	Yes	Yes
Any symptom					
Treatment	0.03	0.30	0.03	0.16	0.03
	(0.04)	(0.33)	(0.03)	(0.18)	(0.03)
	0.38	0.38	0.37	0.37	0.37
R^2 / Hosmer-Lemeshow pval	0.01	0.75		0.87	
Observations	774	774	774	774	774
Controls	Yes	Yes	Yes	Yes	Yes
Too sick					
Treatment	-0.02	-0.30	-0.02	-0.15	-0.02
	(0.02)	(0.29)	(0.02)	(0.15)	(0.02)
	0.30	0.31	0.31	0.30	0.30
R^2 / Hosmer-Lemeshow pval	0.01	0.93		0.76	
Observations	774	774	774	774	774
Controls	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses, followed by pvalues
*** p<0.01, ** p<0.05, * p<0.1

SALDRU

Southern Africa Labour and
Development Research Unit

The Southern Africa Labour and Development Research Unit (SALDRU) conducts research directed at improving the well-being of South Africa's poor. It was established in 1975. Over the next two decades the unit's research played a central role in documenting the human costs of apartheid. Key projects from this period included the Farm Labour Conference (1976), the Economics of Health Care Conference (1978), and the Second Carnegie Enquiry into Poverty and Development in South Africa (1983-86). At the urging of the African National Congress, from 1992-1994 SALDRU and the World Bank coordinated the Project for Statistics on Living Standards and Development (PSLSD). This project provide baseline data for the implementation of post-apartheid socio-economic policies through South Africa's first non-racial national sample survey.

In the post-apartheid period, SALDRU has continued to gather data and conduct research directed at informing and assessing anti-poverty policy. In line with its historical contribution, SALDRU's researchers continue to conduct research detailing changing patterns of well-being in South Africa and assessing the impact of government policy on the poor. Current research work falls into the following research themes: post-apartheid poverty; employment and migration dynamics; family support structures in an era of rapid social change; public works and public infrastructure programmes, financial strategies of the poor; common property resources and the poor. Key survey projects include the Langeberg Integrated Family Survey (1999), the Khayelitsha/Mitchell's Plain Survey (2000), the ongoing Cape Area Panel Study (2001-) and the Financial Diaries Project.

www.saldru.uct.ac.za
Level 3, School of Economics Building, Middle Campus, University of Cape Town
Private Bag, Rondebosch 7701, Cape Town, South Africa
Tel: +27 (0)21 650 5696
Fax: +27 (0) 21 650 5797
Web: www.saldru.uct.ac.za