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Family Networks and Healthy Behaviour: Evidence from Nepal

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ABSTRACT

Models of household decision-making commonly focus on nuclear family members as primary decision-makers. If extended families shape the objectives and constraints of households, then neglecting the role of this network may lead to an incomplete understanding of health seeking behaviour. Understanding the decision-making processes behind care seeking may improve behaviour change interventions, better intervention targeting and support health-related development goals. This paper uses data from a cluster-randomized trial of a participatory learning and action cycle through women's groups (PLA), to assess the role of extended family networks as a determinant of gains in health knowledge and health practise. We estimate three models along a continuum of health seeking behaviour: one that explores access to PLA groups as a conduit of knowledge, another measuring whether women's health knowledge improves after exposure to the PLA groups, and a third exploring the determinants of their ability to act on knowledge gained. We find that, in this context, a larger network of family it is not associated with women's likelihood of attending groups or acquiring new knowledge but a larger network of husband's family is negatively associated with the ability to act on that knowledge during pregnancy and the post partum period.

JEL: I12, I15, I38, D85

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1. Introduction

Economists have long expressed health gains as the result of a household production function in which care seeking is an input (Grossman, 1972; Becker 1973). Models of health production and health care demand (Grossman, 1972; 2000), commonly account for the role of nuclear family members in shaping investments in health. Building on work by Becker (1973, 1974), Jacobson (2000) postulates a framework in which family members have common preferences in health production, assuming family members will obey all decisions made by the family. Bolin et al. (2001) then present a model in which investment in health is decided through a bargaining process within the family[1]. They stress the importance of conflicting interests between husband and wife (Bolin et al, 2001) and in later work, allow for conflict and strategic behaviour within the nuclear family (Bolin et al, 2002).

Few studies considered that nuclear families are embedded within extended family networks. If extended families shape behavioural objectives and constraints, then neglecting this network may lead to an incomplete understanding of health seeking behaviour. The role of extended families may be particularly relevant in poorer settings that are frequently characterized by missing or incomplete safety nets, missing markets and correlated shocks to economic and physical well-being (Cox and Fafchamps, 2008). Understanding the adoption of new knowledge or healthcare practices in this context may support behaviour change interventions, improve intervention targeting and support health-related development goals. While previous studies have analysed the determinants of maternal and neonatal care in Nepal (Niraula, 1994; Acharya and

Cleland, 2000; Hotchkiss 2001), none have yet focussed on the potential role of kinship networks in promoting health gains or losses.

Outside of the health and development discourse, existing literature proposed community and kinship networks as a source of private transfers and financial risk sharing (Cochrane, 1991; Townsend, 1994). Savings and credit associations are practical examples of financial risk sharing within community networks (e.g. van den Brink and Chavas, 1997; Besley, Coate and Loury, 1993; La Ferrara, 2003). The analysis of financial transfers between households had also highlighted their role as risk sharing mechanisms (e.g. Rosenzweig, 1988; Rosenzweig and Stark, 1989; Fafchamps and Lund, 2003), indicating that such transfers usually take place between close relatives (see for example Lucas and Stark, 1985; Fafchamps and Gubert, 2007a).

Other studies of labour markets showed how family networks relay information about job or business opportunities. Granovetter (1995), similarly documented the role that networks play in matching workers and employers, emphasising the important role of weak ties over strong ties in diffusing new information and knowledge. Montgomery (1991) in contrast, proposed a model in which employed workers help their employer identify suitable recruits, who are often relatives (Barr and Oduro, 2002). Munshi (2003) provided evidence of how information about business opportunities circulates in family and ethnic networks. If information about employment opportunities are circulated in this way, it is possible that information about appropriate health behaviour and access to services is also circulated through extended family networks.

While the literature on risk sharing (or opportunity pooling), suggested that extended family networks may positively impact appropriate care seeking, other work suggested this impact may be negative. Numerous studies from economics, anthropology and sociology have found mixed results. Some studies show that networks and family ties can have a negative effect on individual well-being when cultural norms and traditions prevent acting on new information including the adoption of innovative and potentially beneficial behaviours and technologies. For example, Adongo et al. (1997) found that a high risk of social ostracism and familial conflict prevented the uptake of contraceptive use in rural Ghana, even when services were freely available. Similarly, Sear et al. (2003) found that the presence in the household of the husband's mother and, to a lesser extent the husband's father, increased the probability of a woman giving birth in rural Gambia i.e. it increased her fertility rate, together with the associated health risks of high fertility in that context. Conversely, several other studies conducted in Africa and Asia showed that family networks may have a positive influence in matters related to the different stages of childbirth. For example, Aubel et al. (2004) found that Senegalese grandmothers have the ability to learn, to integrate new information into their practices and to positively influence the practices of women in reproductive age. Their results supported the need for future maternal and child health matters programmes to involve grandmothers and in so doing to build on their intrinsic commitment to family well-being. A number of studies have focused on the role of maternal and paternal grandmothers and kin and found that maternal grandmother and maternal kin have positive effect on child survival, child health and nutrition (see among the others: Sear and Mace, 2008). Similarly, Karmacharya et al. (2017) focused on the associations between grandmothers' knowledge and infant and young child feeding practices and tested whether the associations are independent of,

or operate via, maternal knowledge. Their findings suggested that grandmothers' correct knowledge translated into mothers' correct knowledge and, therefore, optimal infant and young child feeding practices.

In the context of an intervention aiming to change health practise through information dissemination, the expected effect of extended family networks on health seeking behaviour may be positive or negative:

1. Family networks may serve as a source of private transfers and risk pooling. Extended family networks might therefore increase women's ability to act on information received and to access appropriate care.
2. Larger families might however, exert more pressure on women to adhere to traditions and social norms in spite of new information received. This would result in less appropriate care-seeking in societies with norms that promote the seclusion of women or the use of traditional practices that carry health risks.

This paper uses cross-sectional data from rural Nepal to empirically test the influence of family networks on positive health practices. In this study we proxy family networks with the number of female relatives living in the same village development committee, distinguishing between women's own relatives and her husband's relatives. Husband and own relatives are differentiated because women in this context tend to live with their husband's families after marriage, usually in extended family groups.

Data collection was embedded within the surveillance system of a cluster randomized control trial to reduce neonatal and maternal mortality. The intervention comprised community-based women's groups working through a participatory learning and action cycle, henceforth PLA (Manandhar et al, 2004; Morrison et al, 2005; Wade et

al, 2006; Mesko et al, 2003; Prost et al, 2013)[2]. The PLA groups disseminated information about appropriate healthcare practices for pregnant women and their newborn children. Women were free to attend or not attend the groups, and were free to act or not act on the information shared at the groups. Evaluation of the trial showed that the intervention reduced neonatal death by 30% in the intervention areas and that women in intervention areas were more likely to have antenatal care, an institutional delivery, a trained birth attendant and hygienic care, than were women in control areas (Manandhar et al, 2004; Prost et al 2013).

In this paper, we explore whether larger family networks are positively or negatively associated with the adoption of these and other potentially beneficial care seeking practices by women during the perinatal period. This paper is organized as follows. Section 2 describes the study location and further detail on the data and data collection. Section 3 describes the analytical methodology and Section 4 presents the main results. Section 5 concludes with a brief discussion of the results and implications for future research in this area.

2. Data

2.1 Study area

The study was based in the district of Makwanpur, a central region of Nepal. It had a population of nearly 400,000 people, covering an area of 2,500 km^2 and including both hills and plains. Most residents were engaged in small-scale agriculture at the time of the trial. There were more than 15 ethnic groups, the largest of which was Tamang (a

predominantly Buddhist, Tibeto-Burman group), followed by Brahmin and Chetri (groups of Indo-Aryan origin). The district was geopolitically divided into 43 village development committees (VDCs). The district hospital in the municipality of Hetauda had facilities for antenatal care and delivery. Perinatal care was available through a network of primary health centres, health posts, sub-health posts and outreach clinics. Traditional birth attendants were available throughout the district, but their services were costly and often not affordable for families (Borghi et al, 2006).

2.2 Data

As mentioned previously, data collection for this study was embedded within the surveillance system of a cluster randomized control trial to reduce neonatal and maternal mortality. For the trial, twelve pairs of village development committees (VDCs) were selected within the district and one of each pair was randomly assigned to the intervention or control group. In the intervention clusters, PLA meetings were organized to identify existing perinatal problems and formulate strategies to address them at a local level[3].

In the second phase of the program, the intervention was extended to the original control areas. During that phase a sub-study aimed to collect data on social networks, spread of information, demographic and socioeconomic characteristics, previous pregnancies, distance to group meetings and distance to health care facilities. These data were collected from the same twelve pairs of village development committees between January 2007 and May 2008. At one month postpartum, women were interviewed about antenatal, delivery and post-delivery care, home-care practices, maternal morbidity, neonatal morbidity and health service use, as well as information

on demographic and socio-economic characteristics. A sub-sample of women were also asked questions about social networks, spread of information within the family, participation in women's group meetings, and distance to the PLA group meetings and health care facilities. These women were asked to list up to five female[4] relatives currently living in the same ward and the same village development committee[5]. Relatives were categorised as sisters, wives of brothers, husband's sisters, wives of husband's brothers, mother and mother in law. This categorisation makes it possible to distinguish between 'own family' (sisters, wives of brothers, and mother) and 'husband's family' (husband's sisters, wives of husband's brothers, and mother is law) as described later in Section 3.

The sample used for the analysis in this paper consists of 1,749 women who answered both the main trial questionnaire and the additional social network questionnaire. The demographic and socio-economic characteristics of the sample are described in detail in *Table 1*. In summary, the average age of the women in our sample is 26 years (sd 6.49), and the average age at marriage is 17 years (sd 2.84). 52% of women in the sample have no education and only 47% of women were able to read a basic line of text. The most common source of drinking water is the river and public pipes (73%) and most homes are constructed from mud and stone (61%). Most women belong to households where the main occupation is agriculture (94%). Women lived an average of half an hour from the nearest PLA group meeting place, and just over an hour from the nearest health care facility.

In *Table 1*, the 15 ethnic groups in our sample are collapsed into four categories as follows: Tamang (66%), Brahmin-Chhetri (14%), Magar (4%) and other (15%). The

wider anthropological literature[6] describes Tamang as the major Tibeto-Burman speaking community in Nepal, who maintain the belief they originate from Tibet. Most Tamang are self-sufficient in terms of food and are the owner-cultivators of their land. The Tamang community is divided into clans that are exogamus. Preferred marriage is between cross-cousins. The Brahmin-Chhetri population, has had a dominant role in the formation of the Nepali nation. They rank highest in the cast hierarchy and form the majority of influential and wealthy people of traditional Nepal. Their main occupations are farming and government service. Among them, the richest are landlords, senior officers in the army or political leaders. Brahmin-Chhetris do not practice cross-cousin marriage. Village exogamy is observed. Magar are mostly Hindu. Agriculture is the basis of the Magar economy, which is largely self-sufficient. Magar are endogamous. Magar women occasionally marry outside the group, but men almost always marry within the group where they can marry anyone within the Magar community except members of their own patrilineage. Again, cross-cousin marriage is preferred. The residual group of ethnicities is heterogeneous. It includes privileged ethnicities such as the Newar, as well as less privileged ethnicities such as Praja and Kami. Newar are the indigenous people of Nepal's Kathmandu Valley and are prominent in every sphere, from agriculture, business, education and government administration to medicine, law, religion, architecture, fine art, and literature.

[TABLE 1 about here]

3. Methodology

To explore the potential role of family networks in influencing health behaviour in this context, we construct three linear regression models. First we estimate the number of times a woman attended PLA groups to establish the determinants of participation. Next we estimate the level of knowledge regarding positive healthcare practices, and the determinants of that knowledge. Finally, we estimate the determinants of positive care practise. In this study we proxy family networks with a count variable that enumerates the number of female relatives living within the same village development committee, distinguishing between women's own relatives and husband's relatives. On average, women in the sample had 1.26 (sd 1.31) 'husband's' female relatives and 1.42 (sd 1.36) 'own' female relatives within the same village development committee.

As group participation, level of knowledge and positive care seeking are all enumerated by continuous variables, we estimate linear regression models specified as follows:

$$PLA_c = \alpha + \beta_1\, wife\_rel_c + \beta_2\, husband\_rel_c + \theta X_c + \varphi_1\, dist\_PLA_c + \varphi_2\, dist\_healthinst_c + \varepsilon$$

Where *PLA* indicates the number of times a women attended the group in cluster *c*. The variables *wife_rel* and *husband_rel* represent, respectively, the number of woman's and husband's relatives. *X* is a vector of socio-demographic characteristics summarised previously in *Table 1* including age, age at marriage, previous pregnancies, ethnicities. This vector also includes a proxy of wealth that is measured using a multi-dimensional poverty index (MPI) (Maasoumi, 1986; Alkire and Foster, 2011; Bourguignon, 2003). The index used in this text covers the same three

dimensions as the Human Development Index i.e. education, health and standard of living[7] and "*captures a set of direct deprivations that batter a person at the same time*" (Alkire and Santos, 2011). In this context, where households may arguably be described as homogenously poor, it is a more comprehensive measure of deprivation that differentiates households in a meaningful way. The variable *dist_PLA* and *dis_healthinst* indicate, respectively, time to reach the nearest PLA and the nearest health institution. ε is an error term that we assume to be independently distributed. The subscript *c*, stands for the cluster (village development committee).

In the model of level of knowledge, we also include PLA participation as an independent variable in a model specified as follows;

$$health\_know_c = \alpha + \beta_1\, wife\_rel_c + \beta_2\, husband\_rel_c + \gamma\, PLA_c + \theta X_c + \varphi_1\, dist\_PLA_c + \varphi_2\, dist\_healthinst_c + \varepsilon$$

Health knowledge (the variable *health_know*) is measured using a count variable that adds up a woman's knowledge of 18 'good' behaviours during the three key stages of childbirth i.e. pregnancy, delivery and the post-natal period. In each instance, respondents were asked what care, in their opinion, mothers needed during each stage. To reduce respondent bias, the list of possible behaviours included positive, negative and neutral behaviours. These behaviours are summarised in *Table 2*, where 'good behaviours' included in the health knowledge count are numbered and those excluded from the count are not. A woman's level of health knowledge is then the sum of the good behaviours of which she is aware. In this sample, respondents were aware of an average of 4.56 (sd 3.12) positive behaviours.

[TABLE 2 about here]

In the model of positive health care we additionally include level of knowledge as an independent variable in a model specified as follows;

$$healthcare_c = \alpha + \beta_1\, wife\_rel_c + \beta_2\, husband\_rel_c + \gamma\, PLA_c + \delta\, health\_know_c + \theta X_c + \\ + \varphi_1\, dist\_PLA_c + \varphi_2\, dist\_healthinst_c + \varepsilon$$

Health behaviour may include a range of possible behaviours as listed in *Table 3*. As with health knowledge, these behaviours span the three key stages of pregnancy, delivery and the post-natal period. To construct a single variable for health behaviour, respondents were asked which behaviours they undertook. These responses were then combined using a first order factorial from a principle components analysis, to form a normalised index of care seeking with a value between 0 and 1. A count measure is not appropriate for this variable as the behaviours are not additive in the same way as knowledge, for example a delivery might take place in a health facility or it may be conducted at home by a skilled birth attendant. Both of these behaviours are positive, but are mutually exclusive. The constructed 'health behaviour index' has a high scale reliability coefficient of 0.7845 and skewness of 0.3668 .

[TABLE 3 about here]

Table 4 shows the descriptive statistics of outcome variables in the three models presented, namely the number of times of PLA attendance, level of knowledge and positive health care index, by four age groups (below the 25th percentile, between the 25th and the 50th percentile, between the 50th percentile and the 75th percentile, and above the 75th percentile). While there is not a clear age-dependent pattern for the

number of times PLA were attended, both level of knowledge and the positive health care index are higher for younger women (age below the median) and are the lowest for older women (age above the 75th percentile).

[TABLE 4 about here]

3.2 Results

The results for the three linear models of PLA participation, health knowledge and health behaviour are summarised in *Table 5*. In all the regressions, confidence intervals consider heteroscedasticity robust standard errors clustered at the community level (Village Development Committees level). Moreover, given the number of communities, we adopted the wild-cluster bootstrap-t procedure, by Cameron et al. (2008). This procedure is shown to improve inference in cases of less than 30 clusters, which is our case since the total number of committees participating in the program is 24.

Estimates for PLA participation in column 1 suggest that family networks do not significantly affect PLA participation. However, women who married later in life or are living further from the nearest PLA group, will attend less often. Conversely, women who have had previous pregnancies or are multi-dimensionally less poor, attend a greater number of groups.

Estimates for health knowledge in column 2 indicate that more frequent PLA participation significantly and positively affects health knowledge. The only other significant determinant of health knowledge is multidimensional poverty: less poor

women have greater knowledge of maternal and newborn care. As with PLA participation, family networks do not affect the level of health knowledge.

Estimates of positive healthcare practices in column 3 show further that the level of knowledge is a positive and statistically significant determinant of good practise. Other positive determinants of good practise include older age at marriage and being multidimensionally less poor. In contrast with the two previous models, the number of husband's relatives in a woman's family network, negatively and significantly predicts care practise. This finding suggests that women living in larger husband's family networks are less likely to adopt good health care practices even with the same level of knowledge as contemporaries with smaller husband's family networks. Other significant negative determinants of health practise include current age (with older women less likely to report positive care practices), having had a previous pregnancy, distance from a PLA group, distance from a health institution and being of Tamang, Magar or other ethnicity relative to Brahmin-Chhetri.

[TABLE 5 about here]

4. Discussion and Conclusion

This paper reviewed the existing literature on the role of family networks in shaping health seeking behaviour. While there have been a number of studies describing the effect of nuclear families on decision making, the potential role of extended family networks is less well understood. Existing evidence was used to explain how the

expected effect of extended family networks on health seeking behaviour may be positive or negative.

This paper used cross-sectional data from rural Nepal to empirically test the role of extended family networks on the acquisition of knowledge about positive health care practices, and then the impact of networks on the practise of positive care in that context. We measure family networks by counting the number of female relatives living in the same local area, distinguishing between women's own relatives and husband's relatives.

We find that in this context, family networks do not affect women's ability to attend PLA groups as the source of knowledge, nor women's ability to absorb and recall knowledge gained at the group. However, family networks are a significant and negative determinant of women's ability to act on the knowledge gained and engage in positive health practices

We find further that the differentiation between own and husband's family network is an important one in this context. While a women's own family network has no significant effect on health behaviour, the size of her husband's family network has a direct and negative effect on health behaviour. The difference in the effect of the two networks (own and husband's) is perhaps unsurprising given that women in this context live within the marital/husband's home and are thus physically located within the husband's extended family network. As such, this network might be considered to consist of strong ties. These data thus provide early evidence for the hypothesis that larger families exert more pressure on women to adhere to traditions and social norms

in spite of new information received. This would result in less appropriate care-seeking in societies with norms that promote the seclusion of women or the use of traditional practices that carry health risks. Unfortunately, our data do not allow us to better investigate the role of tradition and social norms and our interpretation of the results remain speculative. Indeed, there may be other factors driving the results. The main alternative factors leading husband's family network not to support/encourage positive health care practices during the different stages of childbirth might be perceptions by members of the husband's family network that antenatal care or postnatal care were not beneficial based largely on their own past experiences, the scarcity of resources under their control and power relations between mothers-in-law and other husband's family members on the one side and daughters-in-law from the other side.

In addition we find that a higher multidimensional wealth index positively predicts participation in knowledge generating activities (PLA groups in this case), the level of health knowledge, and good health practise. PLA participation is the only other significant predictor of knowledge aside from multidimensional poverty. Level of knowledge in turn positively predicts health practise, as does close proximity to a health institution. Notably having married older positively predicts health practise but negatively predicts group PLA participation and thus ostensibly knowledge acquisition. This is independent of the effect of education, captured within the MPI. Although marrying older negatively effects PLA participation, it does not however significantly affect a woman's level of knowledge. In this context where very early marriage is the norm and 90% of women are married by 20 years of age, older age at marriage may be capturing something other than an age differential – instead measuring a girl (and her family's) willingness and ability to delay marriage. Older age at marriage will

result in older age at first parity and possibly also a higher status within the household. Women in our sample who marry older, have a higher level of education (p=0.00). Women with a higher level of education similarly have a higher level of health knowledge (p=0.00). A brief analysis of PLA non-group participants in this context further shows that women who marry older have a higher level of knowledge than non-participants who marry younger. However, among group participants, the difference in health knowledge is no longer significant. The PLA groups raise the level of knowledge among attendees, and women marrying younger attend more PLA groups resulting in a levelling effect. Controlling then for level of knowledge, women who marry older are then more likely to be able to act on their knowledge. One known limitation of this analysis is our inability to control for the possibly differential and mediating effect of individual empowerment on the acquisition of health knowledge and on resulting behaviour change. Age at marriage may, in part, be capturing this effect and more work is required in this area. Conversely, current age is not a significant predictor of knowledge and is a negative predictor of health practise – suggesting instead that older women may be more likely to adhere to traditional behaviours or less likely to adopt new ideas.

Perhaps unsurprisingly, distance from a PLA group negatively predicts group participation and health practise. Similarly, the distance from a health facility negatively predicts practise.

In conclusion then, the extended husband's family networks within which women reside in rural Nepal are negatively associated with medical 'best practices' for maternal and child health, while no significant association is found for woman's family

networks. One potential explanation is that husband's family networks exert pressure on women to adhere to traditions and social norms that conflict with current thinking around medical 'best practice'. This results in s/lower translation of new knowledge into practise. In this context, we find that analyses of extended family networks should differentiate between women's' own and husbands' relatives, or risk a misleading null result overall. While these findings relate directly to the surveyed communities in Nepal, they may also apply to other comparable societies where families live in extended family groups, with norms that promote the seclusion of women or the use of traditional care practices that carry health risks. These findings suggest that health information and behaviour change interventions targeted at women in this context, will need also to engage the wider family network to maximise their effectiveness. Strategies to delay age at marriage or reduce multidimensional poverty may also improve women's ability to act on health knowledge.

Footnotes

1. Bolin et al. (2001) built their model from Mansen and Brown (1980) that proposed the Nash-bargaining procedure for analysing the allocation of family resources.
2. Manandhar et al. (2004) focus on the effect of the participatory intervention with women's groups on birth outcomes as summarised above. Morrison et al. (2005) focus on the functioning of the women's groups. They describe the implementation including the community entry process, facilitation of monthly meetings, community planning, and implementation and evaluation of strategies to tackle problems within the group discussions. They find that the women's groups developed varied strategies to the tackle problems of maternal and newborn care. Wade et al. (2006) compare perinatal care seeking before and after the intervention. They analyse whether the program increased antenatal care, the use of a boiled blade to cut the cord, appropriate dressing of the cord and retaining colostrum. Among those not initially following good practice, women in intervention areas were significantly more likely to do so later for all four outcomes. Mesko et al. (2003) focus on information gathered from case studies and focus group discussions with women, family members and health workers. They find that early pregnancy was often concealed, preparation for birth was minimal and trained attendance at birth was uncommon. Family members were favoured attendants, particularly mothers-in-law. They find that there were delays in recognizing and acting on danger signs, and in seeking care beyond the household, in which the cultural requirement for maternal seclusion played a part.
3. The Appendix provides a short explanation of the activities organized during the PLA meetings. See Manandhar et al. (2004) and Morrison et al (2005), for a full description of activities in the intervention area. The Appendix also provides a summary description of the ongoing interventions to reduce maternal and child mortality taking place in the same geographic areas of the programme considered in the current study (See Morrison et al. 2011 for details).
4. Families live in large, extended groupings in this context. For simplicity, the decision was therefore taken to ask only about female family members as a proxy for network size.
5. Ward is a smaller geographic unit than the VDC.
6. See for example Gray 2008, Bista 1996 and Kondos 2004.

7. In particular, we considered education level, reading skills, months of food sufficiency, facilities in the house (electricity, radio, television), source of water (pipe, well, river), toilet facilities, house construction materials, number of people living in the same house.

References

Acharya, L. and J. Cleland (2000), 'Maternal and child health services in rural Nepal: does access or quality matter more?', *Health Policy and Planning*, **15**: 223-229.

Adongo, P., Phillips, J., Kajihara, B., Fayorsey, C., Debpuur, C. and F. Binka (1997), 'Cultural factors constraining the introduction of family planning among the Kassena-Nankana of Northen Ghana', *Social Sciences and Medicine*, **45**: 1789-1804.

Alkire, S. and J. Foster (2011), 'Counting and multidimensional poverty measurement', *Journal of public economics*, **95**(7): 476-487.

Alkire, S. and M.E. Santos (2011), 'Acute multidimensional poverty: A new index for developing countries', *Proceedings of the German Development Economics Conference*, Berlin.

Aubel, J., Toure', I., Diagne, M. (2004). Senegalese grandmothers promote improved maternal and child nutrition practices: the guardians of tradition are not averse to change. *Social Science and Medicine*, **59**: 945-959.

Bandiera, O. and I. Rasul (2006), 'Social networks and technology adoption in northern Mozambique', *Economic Journal*, **116**: 869-902.

Barr, A. and A. Oduro (2002), 'Ethnic fractionalization in an African labor market', *Journal of Development Economics*, **68**: 355-379.

Becker, G. (1973), 'A theory of marriage: part 1', *Journal of Political Economy*, **81**: 813-846.

Becker, G. (1974), 'A theory of marriage: part 2', *Journal of Political Economy*, **82**: s11-s26.

Besley, T., Coate, S. and G. Loury (1993), 'The economics of rotating savings and credit associations', *American Economic Review*, **83**: 792-810.

Bista, DB (1996), People of Nepal, Kathmandu: Ratna Pustak Bhandar.

Bolin, K., Jacobson, L. and B. Lindgren (2001), 'The family as the health producer - when spouses are Nash-bargainers', *Journal of Health Economics*, **20**: 349-362.

Bolin, K., Jacobson, L., and B. Lindgren (2002), 'The family as the health producer – when spouses act strategically', *Journal of Health Economics*, **21**: 475-495.

Borghi, J., Ensor, T., Neupane, B. and S. Tiwari S. (2006), 'Financial implications of skilled attendance at delivery in Nepal', *Tropical Medicine and International Health*, **2**: 228-237.

Bourguignon, F., and S.R. Chakravarty (2003), 'The measurement of multidimensional poverty', *The Journal of Economic Inequality*, **11**: 25-49.

Cameron, A.C., Gelbach, J.B. and D.L. Miller (2008), 'Bootstrap-based improvements for inference with clustered errors', *The Review of Economics and Statistics*, **90**(3): 414-427.

Cameron, M. (2005), 'On the edge of the auspicious: gender and caste in Nepal', University of Illinois Press.

Cochrane, J. (1991), 'A simple test of consumption insurance', *Journal of Political Economy*, **99**: 957-976.

Cox, D. and M. Fafchamps (2008), 'Extended Family and kinship network: economic insight and evolutionary direction', in T. Paul Schultz & John A. Strauss (ed.), "Handbook of Development Economics", Elsevier, edition 1, volume 4, number 5,Ch. 58, pp. 3711-3784.

Fafchamps, M. and S. Lund (2003), 'Risk sharing networks in rural Philippines', *Journal of Development Economics*, **71**: 261-287.

Fafchamps, M. and F. Gubert (2007a), 'The formation of risk sharing networks', *Journal of Development Economics*, **83**: 326-350.

Fafchamps, M. and F. Gubert (2007b), 'Contingent loan repayment in the Philippines', *Economic Development and Cultural Change*, **55**: 633-667.

Fricke, T., Axinn, W. and A. Thornton (1993), 'Marriage, Social Inequality, and Women's Contact with Their Natal Families in Alliance Societies: Two Tamang Examples', *American Anthropologist*, 95(2): 395-419.

Granovetter, M. (1995), 'Getting a Job: A Study of Contacts and Careers', second ed. Univ. of Chicago Press, Chicago, IL.

Gray, J. (2008), 'The householders: purity, power and dominance in a Nepal village', Oxford India Paperbacks.

Grossman, M. (1972), 'On the concept of health capital and the demand for health', *Journal of Political Economy*, 80: 223-255.

Grossman, M. (2000), 'The human capital model of the demand for health'. In: Culyer, A.J., Newhouse, J.P. (Eds.), Handbook of Health Economics, Elsevier, Amsterdam, pp. 347-408.

Hotchkiss, D. (2001), 'Expansion of rural health care and the use of maternal services in Nepal', *Health and Place*, **7**: 39-45.

Jacobson, L. (2000), 'The family as producer of health- an extension of the Grossman model', *Journal of Health Economics*, **19**: 611-637.

Karmacharya, C., Cunningham, K., Choufani, J., Kadiyala, S. (2017). 'Grandmothers' knowledge positively influences maternal knowledge and infant and young child feeding practices'. *Public Health Nutrition*, **20**: 2114-2123

Kondos, V. (2004), 'On the Ethos of Hindu Women: Issues, Taboos and forms of Expression', Kathmandu: Mandala Book Point.

LaFerrara, E. (2003), 'Kin groups and reciprocity: A model of credit transactions in Ghana', *American Economic Review*, 93: 1730-1751.

Lucas, R. and O. Stark (1985), 'Motivations to remit: evidence from Botswana', *Journal of Political Economy*, **93**: 901-918.

Maasoumi, E (1986), 'The measurement and decomposition of multi-dimensional inequality', *Econometrica: Journal of the Econometric Society*, **54**: 991-997.

Manandhar, D.S., Osrin D., Prasad Shrestha B., Mesko N. et al. (2004), 'Effect of a participatory intervention with women's groups on birth outcomes in Nepal: cluster-randomised controlled trial', *The Lancet*, **364**: 970-979.

Manser, M. and M. Brown (1980), 'Marriage and household decision theory- A bargaining analysis', *International Economic Review*, 21: 21-34.

Mesko, N., Osrin, D., Tamang, S., Shrestha, B., Manandhar, D., Manandhar, M., Standing, H. and A. Costello (2003), 'Care for perinatal illness in rural Nepal: a descriptive study with cross-sectional and qualitative components', *BMC International Health and Human Rights*, **3**.

Montgomery, J. (1991), 'Social networks and labor-market outcomes: Toward an economic analysis', *American Economic Review*, **81**: 1408-1418.

Montgomery, M., Gragnolati, M., Burke, K. and E. Paredes (2000), 'Measuring living standards with proxy variables', *Demography*, **37**: 155-174.

Morrison, J., Osrin, D., Shrestha, B., Tumbahangphe, K., Tamang, S., Shrestha, D., Thapa, S., Mesko, N., Manandhar, D. and A. Costello (2008), 'How did formative research inform the development of a women's group intervention in rural Nepal?', *Journal of Perinatology*, **28**: S14 - S22.

Morrison, J., Tamang, S., Mesko, N., Osrin, D., Shrestha, B., Manandhar, M., Manandhar, D., Standing, H., and A. Costello (2005), 'Women's health groups to improve perinatal care in rural Nepal', *BMC Pregnancy Childbirth*, **5**.

Morrison, J., Tumbahangphe, K.M., Budhathoki, B., Neupane, R., Sen, A., Dahal, K., Thapa, R., Manandhar, R., Manandhar, D., Costello, A., and Osrin, D. (2011). 'Community mobilisation and health management committee strengthening to increase birth attendance by trained health workers in rural Makwanpur, Nepal: study protocol for a cluster randomised controlled trial'. *Trials*, **12**: 128.

Munshi, K. (2003), 'Networks in the Modern Economy: Mexican Migrants in the U.S. Labor Market', *Quarterly Journal of Economics*, **118**: 549-597.

Niraula, B.B. (1994), 'Use of health services in Hill villages in Central Nepal', *Health Transition Review*, **4**: 151-166.

Pradhan, E., Katz, J., LeClerq, S. and K. West (1994), 'Data management for large community trials in Nepal', *Controlled Clinical Trials*, 15: 220-34.

Prost, A. et al (2013), 'Women's groups practising participatory learning and action to improve maternal and newborn health in low-resource settings: a systematic review and meta-analysis', *The Lancet*, **381**: 1736-1746.

Rosenzweig, M. (1988), 'Risk, implicit contracts and the family in rural areas of low-income countries', *Economic Journal*, **98**: 1148-1170.

Rosenzweig, M. and O. Stark (1989), 'Consumption smoothing, migration, and marriage: Evidence from rural India', *Journal of Political Economy*, **97**: 905-926.

Sear, R., Mace, R. and I. McGregor (2003), 'The effects of kin on female fertility in rural Gambia', *Evolution and Human Behavior*, **24**: 25-42.

Sear, R., Mace, R. (2008). 'Who keeps children alive? A review of the effects of kin on child survival'. *Evolution and Human Behavior*. **29**: 1-18.

Townsend, R. (1994), 'Risk and insurance in village India', *Econometrica*, **62**: 539-591.

van den Brink, R. and J.P. Chavas (1997), 'The microeconomics of an indigenous African institution: The rotating savings and credit association', *Economic Development and Cultural Change*, **45**: 745-772.

Wade, A., Osrin, D., Shrestha, B., Sen, A., Morrison, J., Tumbahangphe, K., Manandhar, D. and A. Costello (2006), 'Behaviour change in perinatal care practices among rural women exposed to a women's group intervention in Nepal', *BMC Pregnancy Childbirth*, **6**: 6-20

Tables

Table 1: Descriptive demographic and socioeconomic statistics

Variable		Obs	Mean	Std. Dev.	Min	Max
Age		1749	25.610	6.489	13	48
Age at marriage		1748	17.322	2.839	3	39
Education:	None	1749	0.523	0.500	0	1
	Primary	1749	0.228	0.419	0	1
	Secondary	1749	0.149	0.356	0	1
	Adult education	1749	0.101	0.301	0	1
Literacy		1748	0.466	0.499	0	1
Ethnicity:	Tamang	1749	0.664	0.473	0	1
	Brahmin-Chhetri	1749	0.142	0.350	0	1
	Magar	1749	0.040	0.196	0	1
	Other	1749	0.154	0.361	0	1
Total land		1749	17.767	14.446	0	182
No. of people in the household		1749	7.312	3.334	0	28
No. of sleeping rooms		1749	2.058	1.133	0	12
No. of people per sleeping room		1704	4.105	2.159	0.3	25
Main household occupation:	Agriculture	1749	0.935	0.247	0	1
	Salaried Job	1749	0.035	0.185	0	1
	Government job	1749	0.018	0.134	0	1
	Small Business	1749	0.011	0.106	0	1
Assets:	Electricity	1749	0.449	0.498	0	1
	Radio	1749	0.665	0.472	0	1
	Television	1749	0.178	0.383	0	1
	Bicycle	1749	0.067	0.250	0	1
	Telephone	1749	0.075	0.263	0	1
House construction material:	Cement & bricks, mud & bricks	1704	0.070	0.255	0	1
	Mud & stone	1704	0.613	0.487	0	1
	Planks, brushwood, thatch and other	1704	0.317	0.466	0	1
Source of drinking water:	Piped	1749	0.109	0.311	0	1
	Well, yard well, public well	1749	0.181	0.385	0	1
	River	1749	0.739	0.439	0	1
PLA group attendance		1749	0.314	0.464	0	1
Number of times PLA attended		1749	2.140	5.785	0	70
Distance to PLA women's group (in minutes)		1749	29.818	35.098	1	360
Distance to health care facility (in minutes)		1749	68.511	45.789	1	280

Table 2: Descriptive Statistics Known Behaviours/Cares required

		Obs	Mean	Std.Dev	Min	Max
Pregnancy	Do antenatal check up	1,749	0.501	0.500	0	1
	Avoid heavy work and weight	1,749	0.604	0.489	0	1
	Feed nutritious food	1,749	0.595	0.491	0	1
	Take to health institution if problem occurs	1,749	0.107	0.310	0	1
	Take tetanus injection	1,749	0.258	0.438	0	1
	Take folic acid	1,749	0.242	0.429	0	1
Delivery	Keep the delivery room warm and clean	1,749	0.286	0.452	0	1
	Ask about health condition	1,749	0.071	0.258	0	1
	Arrange clean delivery kit	1,749	0.121	0.326	0	1
	Call trained person	1,749	0.062	0.241	0	1
	Boil the blade and thread	1,749	0.069	0.254	0	1
	Arrange to take hospital	1,749	0.139	0.346	0	1
Postnatal period	Feed nutritious food	1,749	0.820	0.384	0	1
	Take to PNC	1,749	0.050	0.217	0	1
	Take folic acid	1,749	0.134	0.341	0	1
	Take Vitamin A	1,749	0.110	0.313	0	1
	Avoid heavy work	1,749	0.318	0.466	0	1
	Arrange to take hospital if problem occur	1,749	0.075	0.263	0	1
Total pregnancy, delivery and postnatal period		1,749	4.564	3.122	0	18

Table 3: Descriptive Statistics Care Seeking Behaviours

		Obs	Mean	Std.Dev	Min	Max
Pregnancy	Had an antenatal check up	1,749	0.655	0.476	0	1
	Had a tetanus injection	1,748	0.637	0.481	0	1
	Took iron tablets or iron syrup	1,739	0.672	0.470	0	1
Delivery	Delivery took place at a health facility	1,703	0.157	0.364	0	1
	Delivery conducted by skilled birth attendant	1,703	0.177	0.382	0	1
Postnatal period	Did not discard colostrum	1,703	0.735	0.442	0	1
	Took Vitamin A after the delivery	1,749	0.436	0.496	0	1
	Had a postnatal checkup	1,749	0.044	0.205	0	1
	The cord was dressed	1,678	0.857	0.350	0	1
	The cord was cut with a clean blade	1,687	0.495	0.500	0	1
Positive Health Care Index (normalized)		1,640	0.438	0.260	0	1

Table 4: Descriptive Statistics PLA attendance, level of knowledge and positive care index by age groups

	Age group	Obs	Mean	Std. Dev.	Min	Max
Number of times PLA attended	≤21	530	1.379	3.630	0	45
	22-24	409	2.421	6.462	0	60
	25-29	390	2.513	6.534	0	70
	30+	420	2.486	6.451	0	70
Level of Knowledge	≤21	530	4.925	3.188	0	18
	22-24	409	4.895	3.185	0	18
	25-29	390	4.433	2.999	0	16
	30+	420	3.910	2.983	0	18
Positive Care Index	≤21	484	0.501	0.248	0.03	1
	22-24	391	0.503	0.254	0	1
	25-29	371	0.420	0.258	0.03	1
	30+	394	0.313	0.233	0.03	1

Note: The age 21, 24, 29 years correspond to the 25th, 50th a 75th percentile of the women's age distribution.

Table 5: Regressions for PLA participation, level of knowledge and positive health care practice

	(1) # times PLA attendance		(2) Level of knowledge		(3) Positive Health Care Index	
Number of woman's relatives	0.071	0.458	-0.009	0.889	-0.005	0.118
	(0.092)		(0.067)		(0.003)	
Number of husband's relatives	0.066	0.537	0.031	0.645	**-0.017*** **	0.002
	(0.113)		(0.072)		(0.004)	
Level of knowledge					**0.012** **	0.000
					(0.005)	
Age of woman	0.085	0.749	-0.066	0.446	**-0.014** **	0.028
	(0.253)		(0.094)		(0.006)	
Age of woman squared	-0.001	0.933	0.000	0.947	0.000	0.191
	(0.005)		(0.001)		(0.000)	
Age at marriage	**-0.142** **	0.022	0.054	0.977	**0.012*** **	0.000
	(0.058)		(0.035)		(0.002)	
Previous pregnancy	**1.305*** **	0.002	0.011	0.184	**-0.045** **	0.022
	(0.436)		(0.249)		(0.018)	
Ethnicity: Tamang	0.116	0.857	-0.104	0.891	**-0.169*** **	0.000
	(0.659)		(0.752)		(0.023)	
Ethnicity: Magar	1.048	0.414	0.602	0.623	**-0.117*** **	0.006
	(1.040)		(0.960)		(0.038)	
Ethnicity: Other	0.550	0.462	0.089	0.899	**-0.121*** **	0.002
	(0.646)		(0.646)		(0.035)	
Multidimensional Poverty Index	**0.345*** **	0.004	**0.202** *	0.136	**0.038*** **	0.000
	(0.113)		(0.110)		(0.007)	
PLA group distance (minutes)	**-0.024*** **	0.004	-0.007	0.184	**-0.001*** **	0.004
	(0.007)		(0.005)		(0.000)	
PLA group attendance (times)			**0.114*** **	0.000	-0.000	0.976
			(0.022)		(0.001)	
Time nearest health institutions	-0.003	0.432	-0.002	0.513	**-0.001*** **	0.000
	(0.004)		(0.003)		(0.000)	
Constant	1.657		**4.746*** **		**0.576*** **	
	(2.887)		(1.064)		(0.079)	
Observations	1703		1703		1703	
R-squared	0.058		0.107		0.403	

Notes: Statistical significance at the 99% (***), 95% (**) and 90% (*) confidence levels. Confidence intervals consider heteroscedasticity robust standard errors clustered at the community level and are calculated considering the wild-cluster bootstrap-t procedure.

Appendix[1]

i) The Primary Participatory Learning and Action Group Trial

As mentioned in the "Data" section, our study takes advantage of an existing surveillance system, designed around a large cluster randomised controlled trial of participatory action and learning groups. The original trial was conducted between 2001-2003 and led by the UCL Institute for Global Health, in partnership with Nepali NGO Mother and Infant Research Activities (MIRA). The intervention consisted of monthly community-based participatory learning and action group meetings, facilitated by a local non-health professional. Group participants explored health issues around pregnancy, childbirth and newborn health.

The primary cycle consisted of a series of ten meetings where the following issues were discussed:

1. The work of the MIRA team is introduced;
2. Discussion of how mothers and babies might die;
3. Discussion of how women approach maternal and neonatal issues;
4. Discussion of common local maternal and neonatal problems;
5. Planning of methods to collect information on the relevant issues in the community;
6. Sharing of the information collected. Identification of the most important problems;
7. Discussion of strategies for addressing these problems;
8. Planning of the involvement of other community members;
9. Preparation for a meeting with other community members;
10. Presentation of the previous work to other community members. Discussion of strategies with other community members.

The form of the intervention could not be defined in advance since the nature of the discussion, levels of involvement and potential solutions differ from group to group.

ii) Expanding the primary trial location and activities

[1] This section draws heavily on a similar description provided in Gram et al, Plos One, In press.

Given the significant impact on mortality of the primary trial, UCL and MIRA had an ethical commitment to offer the intervention to the control areas. After a 2-year preparation period from 2003-2005, the original intervention was rolled out in the control arm, while a revised intervention focusing on care-seeking for childhood illness and involving men in maternal and newborn health was rolled out in the intervention arm.

iii) The Local Health Management Committee Trial

In January 2009 all participatory learning and action group activities were suspended in preparation for a new trial, the "Local Health Management Committee (LHMC) Trial", which combined PLAs with the strengthening of Health Management Committees (HMC) to increase skilled birth attendance. All of the 43 VDCs in Makwanpur district were randomized to intervention or control (independent of previous randomisation in the original trial) with 21 in intervention and 22 in control. No groups were run in control clusters of the LHMC trial by UCL or MIRA. The trial ran from 2010 to 2012 after which all activities closed.

The intervention used the principles of the 'four D' cycle of discovery, dream, design and destiny. A consultant conducted a training of trainers with MIRA researchers, representatives from the District Public Health Office, District Development Committee, and Family Planning Association of Nepal. Four-day workshops were then conducted in local health facilities in each of the intervention VDCs, over four months. These workshops were attended by a district level representative who had also

attended the training of trainers. During the workshop participants were exposed to the description of the maternal and newborn health situation in Nepal and government strategies and priorities.

After briefing participants about the 'four-D' intervention, participants were invited to follow the 'D'cycle:

- 'Discover' the success of their health institutions and remember who provided support or resources to facilitate this success;
- 'Dream' of how health institutions and the quality of services should be in order to guarantee appropriate maternal and newborn care;
- 'Design' a strategy to achieve their vision;
- 'Destiny': the last phase of this intervention is completed after Health Management Committees have implemented their plans, and participants present their accomplishments and the lessons learned.

iv) Suspension of active engagement in the area

From Oct 1, 2012 to Jan 2014 all intervention, programme and surveillance activities led by UCL and MIRA ceased in the region. Follow up activities are planned but not currently ongoing.