Home gardening and access to animals in households with xerophthalmic children in rural Nepal

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Abstract

This case–control study compares the home garden and animal husbandry practices of households with and without xerophthalmic children in south-central Nepal, focusing on the relationship between these practices and household intake of vitamin A–rich foods. Eighty-one households with a child between the ages of one and six years diagnosed with xerophthalmia (cases) and 81 households with an age-matched, non-xerophthalmic child (controls) were studied. There was little difference between case and control households in the size of their gardens. However, case households were significantly less likely to plant carotenoid-rich vegetables from October to March than were control households (odds ratio, 0.39; 95% confidence interval, 0.16 to 0.96). The mean consumption of non-carotenoid-rich vegetables, but not of carotenoid-rich vegetables, increased linearly with garden size. Case households were significantly more likely than control households to rent domesticated animals from others ($\chi^2 = 5.91$; p < .05). Control households were more likely than case households to own chickens and pigeons ($\chi^2 = 6.6–9.2$; p < .05). During specific seasons, household meat consumption was significantly lower in case households, regardless of access to animals. Case households appeared to have significantly lower intakes of key vitamin A–rich foods, particularly green leaves and meat, regardless of their socio-economic level (as determined by ownership of material goods), access to animals, or availability of home gardens.

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Introduction

In areas where vitamin A deficiency is a serious public health problem, childhood xerophthalmia is known to cluster at the regional, district, village, and household levels [1]. This clustering is thought to be the result of pockets of relative poverty and/or poor access to vitamin A–rich food sources [2–5]. Despite this, there are a number of households living in these same high-risk clusters that do not experience xerophthalmia. One explanation is that these households have developed strategies that allow greater access to vitamin A–rich foods.

Cultivation of home gardens and ownership of domesticated animals are potential ways of increasing household access to foods rich in vitamin A and carotenoids. Numerous attempts have been made to implement gardening programmes towards such a goal [6, 7]. Indeed, several studies have found that the presence of a home garden is a strong predictor of the quality of child nutrition, particularly during seasons when employment opportunities are few [8–10].

Although home gardens have been shown to provide a number of economic and dietary advantages to poor families, the evidence linking home gardens to reduced vitamin A deficiency in vulnerable household members is equivocal. In Bangladesh, analyses indicate that even a small household garden affords protection against childhood xerophthalmia [4]. More recent work from this region [11] shows that the variety of plants in a garden, and not its size, is associated with reduced risk of xerophthalmia. Other studies, however, show that vitamin A status may not improve despite successful home gardening efforts [12, 13]. In West Java, well-off households (those with home gardens and land) were found to consume more of all nutrients than did poorer households, except for vitamin A and calcium [14].

Household-level interventions directed towards improving vitamin A status have focused on increasing plant sources of vitamin A by encouraging home gardens, which require a relatively small investment and can be a source of abundant carotenoid-rich foods. Domestic animals are an additional source of home food that intervention studies and programmes often overlook. Domestic animals provide milk, eggs, and meat that may help protect household members from vitamin A deficiency.

In this study we explore the variations in access to domesticated animals and differences in home gardening practices in households with and without xerophthalmic children in rural Nepal. These practices are then examined with respect to the changes in intake of carotenoid- and retinol-rich foods at the household level over a one-year period.

Methods

A community-wide ocular survey was conducted in January 1992 on 3,735 pre-school children living in three Village Development Committees with a population of approximately 15,000 in Sarlahi District in the central lowland region of Nepal. The survey identified 86 households with children aged 12 to 72 months who had clinical signs of xerophthalmia or a current history of night-blindness. Five households were lost because of migration or refusal to participate, resulting in 81 case households participating in the study. Thirty-three of the children had guardian-reported night-blindness alone, 33 had Bitot's spots alone, and 10 children had both night-blindness and Bitot's spots. The remaining five were diagnosed with corneal xerosis alone or with Bitot's spots or night-blindness.

From the pool of neighbouring households (within 5 km of the case), 81 control households were selected that had a child of the same age as the case child (within three months) and a younger sibling of similar age (within four months), if a younger sibling was present in the case household. In control households, there were no clinical signs of xerophthalmia in any child in the household and no reported history of night-blindness in children or their mothers. Both case and control households were studied prospectively from March 1993 to June 1994.

A recall of home gardening practices was obtained from the head of the household, usually a male, three times during the year: April–May 1993 (three-month recall period), August–September 1993 (four-month recall period), and February–March 1994 (five-month recall period). For the purposes of this study, a home garden was defined to include all plants (fruits and vegetables) grown in and around the homestead. We used specific local terms to distinguish home gardens from agricultural plots. During each round of interviews, recall data were collected on which vegetable and fruit plants were grown in the home garden, the quantity grown, and about how much of the produce was consumed in the household. Harvesting and consumption of green leaves associated with gourds (such as pumpkin leaves) were also noted.

The size of the vegetable garden was calculated by summing the total plot sizes used for each type of plant grown. If one plot area was used for two different crops (planted simultaneously or at different times), the total garden size equalled twice the actual land area used by the plants. In addition, individual vines and plants, such as gourds and tomatoes, grown outside a formal plot were counted separately and assigned an average value of 0.5 square feet (464 cm^2) per plant. As a result of varying planting and harvesting intervals during the recall period, the calculation of garden size is not representative of the actual amount of cultivated land.

Only fruit plants and trees that produced fruit during the year surveyed were counted. The informants were asked to recall all vegetables and fruit plants to which their family had access and from which they were able to obtain some produce, such as plants shared with relatives or neighbours. Fruits or leaves found in the wild were not included within our definition of home garden.

Possession of domesticated animals was determined once by a survey conducted with the head of the household in January 1993. In Nepal there are several forms of animal ownership, ranging from outright ownership to renting and raising animals for a pre-determined portion of the meat or milk produced. Ownership of an animal, for this study, means that the owner has access to all milk or eggs produced by the animal and all the meat if the animal is slaughtered. Rental of an animal means that part of the animal products are kept by the owner and part by the household renting the animal. The numbers of animals owned, rented from others, and rented to others were determined for each household.

Household dietary intake was assessed with a previously described seven-day food-frequency questionnaire [15]. The food-frequency questionnaire was administered four times during the year beginning in July 1993: July to September, October to December, January to March, and April to June. Dietary recalls were conducted on individuals knowledgeable about the household and the food intake of the children, usually the mothers. Household intake was defined as foods consumed by any member of the household, focusing on foods consumed during the primary mealtimes.

Fruits and vegetables were classified as carotenoid-rich or non-carotenoid-rich on the basis of regional and international food composition tables [16, 17]. Vegetables classified as carotenoid-rich included dark-green leafy vegetables and ripe pumpkin; fruits classified as carotenoid-rich included papayas, mangoes, and jackfruit.

Matched-pair odds ratios and 95% confidence intervals were derived by conditional logistic regression to compare household characteristics according to xerophthalmia status. All odds ratios were adjusted for socio-economic status, which was a scaled variable based on the number of different types of material possessions not related to either home gardening efforts or the upkeep of animals. The final scale had eight items in currently usable condition: flashlights (one or more), watches (one or more), bicycles (one or more), armoires (one or more), beds (two or more), number of rooms in the house (two or more), a roof constructed of a material other than straw, and irrigation pump sets. The alpha coefficient for this scale was 0.78 and the mean score value was 3. Those households with a scale score equal to or greater than the mean were classified as having higher socio-economic status (a value of 1 in the regression equation); those below the mean were classified as having lower socio-economic status (a value of 0).

Odds ratios (OR) of less than 1 indicate that case households were less likely than controls to report a practice (e.g., intake of foods). For analyses that required further stratification of the data, unmatched-pair analyses were conducted. Analyses were carried out using SAS (SAS version 6.11, SAS Institute, Cary, NC, USA).

Oral informed consent was obtained from families before participation in the study. This study was approved by the Nepal Health Research Council in Kathmandu and the Committee for Human Research, Johns Hopkins University School of Hygiene and Public Health, Baltimore, Maryland, USA.

Results

Household gardening patterns

Table 1 lists the most common fruits and vegetables grown over the year by case and control households. The types of vegetables and fruits planted and picked differ little between the two groups. An exception, however, is *munga*, a type of long thin gourd, which was planted significantly more frequently in control households. No difference was noted in access to gardens: more than 97% of all study households reported access to some type of home garden during the year, approximately 95% (97% cases, 94% controls) of the households cultivated vegetables, and more than 81% (80% cases, 84% controls) produced fruits. Likewise, no difference was found in the percentage (which averaged 60%) of vegetable and fruit harvests that the household reported were completely consumed.

Garden size varied during the year, with the smallest gardens being planted from June to September and the largest from October to March. Table 2 compares case and control households with respect to garden size and composition according to season. There were no significant differences in garden size between case and

TABLE 1. Percentage of households with access to garden vegetables and fruits during the year, according to case status

Common name	Scientific name	Cases (n = 79)	Controls (n = 77)
Vegetables			
Sponge gourd	*Luffa cylindrica*	84	75
Green chilies	*Capsicum annum grossa*	72	64
Green peas	*Pisum sativum*	66	64
Gourd	*Lagemaria siceraria*	66	62
Potato	*Impomea batas-convulacea*	58	69
Pointed gourd	*Trichosonthes dioica*	58	66
Munga	Gourd, like *Moringa oleifera*	37	55[a]
Eggplant	*Solanum melongena-solonacea*	33	34
Carotenoid-rich vegetables			
Pumpkin	*Cucurbita minima*	68	77
Garlic leaves	*Allium sativum*	57	65
Mustard leaves	*Brassica compestris-cruciferae*	46	51
Dhaniya leaves	*Coriander sativum*	32	34
Thadiya leaves	Name unknown	32	23
Radish leaves	*Raphnum sativus-crucifera*	25	32
Fruits			
Banana	*Musa sapientum*	52	53
White guava	*Psidium guajava*	57	49
Custard apple	*Annona squamosa*	23	28
Carotenoid-rich fruits			
Papaya	*Carica papaya*	71	65
Mango	*Mangifera indica*	52	56
Jackfruit	*Artocarpus integrifolia*	48	49

a. Statistically significant at $p < .05$.

control households over the whole year; however, control households tended to have larger gardens than case households from October to March (OR, 0.41; 95% CI, 0.17 to 1.01). From October to March only, control households were significantly more likely than case households to plant and consume at least one carotenoid-rich vegetable (OR, 0.39; 95% CI, 0.16 to 0.96). This difference is mainly a result of the greater number of garlic leaves and onion greens consumed in control households during this period.

Figure 1 shows the relationship between average cumulative garden size and vegetable consumption for the year for both vitamin A–rich foods and those lacking significant amounts of vitamin A. Pooled data were used for these comparisons, as garden size did not significantly differ between cases and controls. Consumption of non–vitamin A–rich vegetables was found to increase with garden size, whereas consumption of vitamin A–rich vegetables remained low across the observed range of garden sizes. A similar analysis was performed for fruit consumption (fig. 2). In this case, households without gardens had roughly half the mean intake of carotenoid-rich fruits as households with large gardens, although this difference was not statistically significant.

Patterns of animal husbandry

Table 3 compares case and control households with respect to their access to domesticated animals. Nearly all households (90% of cases and 95% of controls) had at least one animal in their home, and nearly 50% of case and control households had a milk-producing animal. However, case households were more likely than controls to have rented animals from others, especially cows. Moreover, nearly twice as many control households as case households had chickens, and three times as many control households as case households had

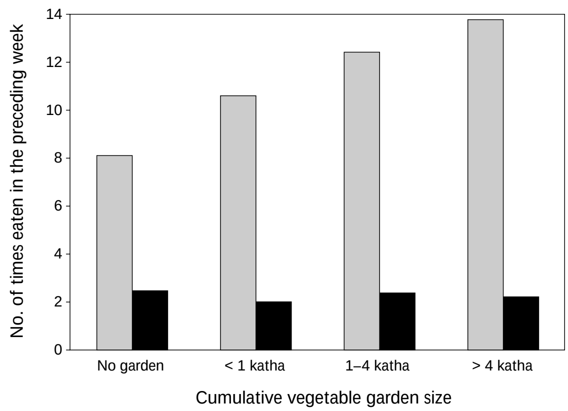

FIG. 1. Average weekly household consumption of low-carotenoid (grey bars) and carotenoid-rich (black bars) vegetables by all study households over the year. according to size of vegetable garden. 1 katha = 0.083 acres = 0.034 hectares

TABLE 2. Matched-pair adjusted odds ratios of garden characteristics for case and control households

Garden characteristic	Feb–May 1993			Jun–Sep 1993			Oct 1993–Mar 1994		
	Case–control pairs (*n* = 78) (%)	OR[a]	95% CI	Case–control pairs (*n* = 78) (%)	OR	95% CI	Case–control pairs (*n* = 77) (%)	OR	95% CI
Cumulative plot size[b] (> 1 katha of land)	63 59	1.49	0.74–3.02	22 16	1.80	0.75–4.32	58 71	0.41	0.17–1.01
> 10 single vines, bushes	44 49	0.84	0.44–1.61	62 58	1.27	0.62–2.62	43 46	0.95	0.47–1.94
> 10 harvesting fruit plants	17 21	0.86	0.36–2.02	33 41	0.87	0.45–1.69	22 36	0.67	0.33–1.35
Carotenoid-rich vegetables harvested and consumed in household	64 71	0.82	0.41–1.65	24 27	0.92	0.45–1.92	72 87	0.39	0.16–0.96[c]
Carotenoid-rich fruits harvested and consumed in household	39 45	0.82	0.43–1.57	39 45	0.70	0.36–1.39	47 42	1.40	0.74–2.65

a. OR, odds ratio; OR < 1 indicates that case households are less likely than control households to report a practice.
b. 1 katha = 0.083 acres = 0.034 hectares. Garden size includes calculation of single vines and bushes with designated plot size of 0.5 sq. ft. (464 cm^2) per plant.
c. $p < .05$.

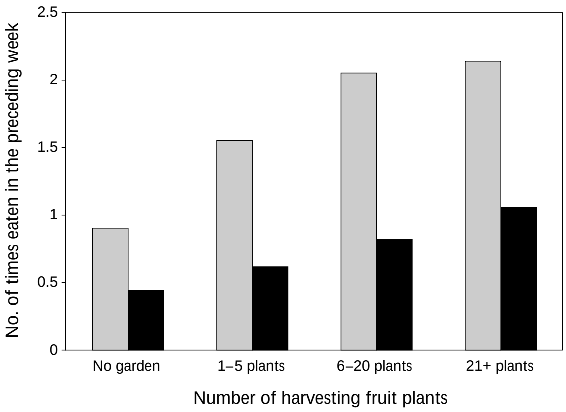

FIG. 2. Average weekly household consumption of low-carotenoid (grey bars) and carotenoid-rich (black bars) fruits by all study households over the year. according to number of fruit plants

pigeons. Chickens and pigeons are both good sources of vitamin A–rich eggs and meat, including liver.

Using household food-frequency data, table 4 examines differences in milk consumption by any household member in the previous week, stratified by access to milk-producing animals. Comparisons are made for three groups: (1) households with no milk-producing animals, (2) households with milk-producing animals (either rented or owned), and (3) households that owned but did not rent milk-producing animals (a subset of group 2). Preliminary unadjusted odds ratios indicated that regardless of access to milk-producing animals (rented or owned), case households were significantly less likely than control households to have consumed milk during the periods from July to September and from October to December (odds ratios ranged from 0.16 to 0.33). However, adjustment for socio-economic status removed any significant differences in milk consumption between case and control households.

Meat (including liver) and eggs are also good sources of pre-formed vitamin A. Animals most likely to be domesticated for consumption include chickens, pigs, goats, and pigeons. Table 5 compares case and control households with and without access to these animals with respect to their consumption of meat and eggs. Among households without access to animals, case households were much less likely to report consumption of meat or eggs in the preceding week than controls (odds ratios ranged from 0.07 to 0.69), with significant differences during the period from January to March. Among households with access to animals, case households were significantly less likely than controls to report consumption of meat or eggs in the preceding week during the period from October to December (OR, 0.41; 95% CI, 0.20 to 0.82).

Discussion

In this paper we differentiate households with a xerophthalmic child from those having a non-xerophthalmic child of the same age, with respect to two factors that could influence the intake of vitamin A–rich foods: home gardens and access to domesticated animals. After controlling for socio-economic status and season, the presence or absence of these factors was related to household intake of vitamin A–rich foods.

Previous dietary analyses from this study indicated that control households consumed more carotenoid-rich vegetables from July to December than case households [15]. The current data corroborate previous find-

TABLE 3. Percentage of case (n = 81) and control (n = 81) households raising animals, renting animals from others, or renting animals to others

Animal	Raising animals		Renting animals from others		Renting animals to others	
	Case	Control	Case	Control	Case	Control
Cows	25	26	11	0[a]	3	7
Bulls and calves	56	58	10	7	3	4
Buffaloes (female)	6	9	0	0	0	0
Buffaloes (males and calves)	21	35	9	9	3	5
Goats (female)	24	25	4	4	1	0
Goats (males and kids)	56	58	23	20	5	12
Pigs	4	6	2	0	0	2
Chickens	26	46[a]	6	5	1	4
Pigeons	6	20[a]	0	0	0	0
Any milk-producing animal (cows, buffaloes, goats)	48	47	15	4[a]	4	7
Any animal	90	95	43	31	11	24[a]

a. $p < .05$ (unmatched pair analyses).

TABLE 4. Non-adjusted and adjusted[a] odds ratios for milk consumption (at least once per household in the past week), based on access to milk-producing animals,[b] for cases and controls, according to year and months

Year and months	No access		Access[c]		Owned animals	
	OR	95% CI	OR	95% CI	OR	95% CI
1993 Jul–Sep						
Non-adjusted	1.25	0.48–3.23	0.32	0.12–0.80[d]	0.33	0.12–0.89[d]
Adjusted	1.07	0.45–2.51	0.73	0.34–1.57	0.61	0.26–1.43
1993 Oct–Dec						
Non-adjusted	1.56	0.62–3.97	0.16	0.06–0.45[d]	0.21	0.07–0.61[d]
Adjusted	1.30	0.53–3.15	0.57	0.26–1.26	0.55	0.24–1.28
1994 Jan–Mar						
Non-adjusted	1.10	0.37–3.30	0.41	0.16–1.02	0.46	0.17–1.23
Adjusted	0.96	0.33–2.78	0.79	0.33–1.90	0.82	0.31–2.15
1994 Apr–Jun						
Non-adjusted	0.47	0.17–1.26	0.69	0.28–1.71	0.90	0.34–2.39
Adjusted	0.41	0.15–1.12	1.41	0.58–3.43	1.78	0.63–5.06

a. Odds ratios adjusted for socio-economic level as determined by a scaled variable of material possessions owned.
b. Female cows, buffaloes, and goats.
c. Households raising animals, either owned or rented.
d. $p < .05$.

ings by showing that control households were more likely to consume carotenoid-rich vegetables from their gardens from October to March as well. The increased intake of carotenoid-rich foods found in the previous analyses may be due in part to the greater access to garden vegetables during certain months of the year.

TABLE 5. Non-adjusted and adjusted[a] ratios for consumption of meat or eggs (at least once per household in the past week), based on access to commonly used animals,[b] for cases and controls, according to year and months

Year and months	No access		Access[c]	
	OR	95% CI	OR	95% CI
1993 Jul–Sep				
Non-adjusted	0.42	0.08–2.33	0.60	0.28–1.26
Adjusted	0.69	0.14–3.29	0.69	0.34–1.38
1993 Oct–Dec				
Non-adjusted	0.19	0.03–1.11	0.31	0.14–0.67[d]
Adjusted	0.34	0.06–1.92	0.41	0.20–0.82[d]
1994 Jan–Mar				
Non-adjusted	0.07	0.01–0.47[d]	0.70	0.32–1.52
Adjusted	0.08	0.01–0.91[d]	0.77	0.37–1.63
1994 Apr–Jun				
Non-adjusted	0.39	0.56–2.73	0.71	0.35–1.48
Adjusted	0.65	0.11–3.91	0.80	0.42–1.51

a. Odds ratios adjusted for socio-economic level as determined by a scaled variable of material possessions owned.
b. Pigeons, chickens, pigs, and goats.
c. Households raising animals, either owned or rented.
d. $p < .05$.

The likelihood of improving consumption of vitamin A–rich foods from the garden, however, is not dependent on garden size. Larger garden sizes were not found to be associated with reported intake of dark-green leafy vegetables and pumpkin. This result supports those of other studies [8, 14] showing that higher economic status may not result in greater consumption of carotenoid-rich vegetables. On the other hand, there was a corresponding increase in the consumption of non-carotenoid-rich vegetables with garden size. As in other areas of South Asia, in Nepal dark-green leafy vegetables are often considered low-status foods, which may explain, in part, why increasing the areas of home gardens does not increase the number of times carotenoid-rich vegetables are eaten.

In this population, access to gardens was high and did not differ significantly between case and control households. Nevertheless, the mean consumption of carotenoid-rich fruits and vegetables was extremely low, averaging less than four times in the preceding week. We also found an increase in the consumption of all fruits as garden size increased. Additional efforts to promote home gardens will likely need to focus on greatly increasing the number of types of carotenoid-rich foods planted and consumed in the household.

Access to domesticated animals is another household strategy that may increase vitamin A intake at the household level but is often omitted from the home-gardening literature. In our sample, both case and control households had access to some type of domesticated animal. However, the form of ownership varied: case households were more likely to rent animals than to own them. In addition, control households were significantly more likely than case households to own chickens and pigeons. This may be indicative of the slightly better socio-economic status of the control households, a finding consistent with other research in the area [3].

In an effort to control for the effects of socio-economic status on diet, we devised a socio-economic status scale that could serve as a proxy for household income but would not include items on ownership of land or animals. When this variable was included in the regression analysis, we found that socio-economic status did influence the odds ratios of household milk consumption but not those of consumption of meat and eggs. In the case of milk consumption, the odds ratios adjusted for socio-economic status were higher (0.5 to 0.7) than the unadjusted odds ratios (0.2 to 0.3), which implies that although control households had greater reported milk intake than cases, this was probably due in part to the slightly higher economic status of these households.

This was not true with consumption of meat or eggs; case households consumed meat or eggs significantly less frequently than controls in certain seasons, regardless of access to animals or socio-economic status. In households with no access to animals, the odds ratios for consumption of meat or eggs were low (0.07 to 0.69), suggesting that control households, even those without direct access to meat or eggs at home, were still able to obtain and consume meat or eggs more often than case households.

As efforts continue to identify household strategies that increase the intake of vitamin A–rich foods [18, 19], understanding the intricacies of current household practices and their relationship to diet is critical. This study demonstrates that household-level access to home gardens or domesticated animals does not ensure that vulnerable members within the household will be able to obtain a diet adequate to prevent clinical signs of vitamin A deficiency. In addition, the size of a garden did not appear to be related to the intake of carotenoid-rich vegetables in this population. From previous analyses [15] we learned that case households and index children were significantly less likely to consume meat, liver, and eggs. This finding holds true in the current analysis, which indicates that other factors besides household access to domesticated animals or socio-economic level (as determined by ownership of material goods) may influence household intake during critical periods of the year. This study is a first step in examining household strategies and their effect on household intake. Further research to identify other types of household strategies and characteristics important for increased consumption of vitamin A–rich foods is warranted.

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