



# Human and Animal Health in Nomadic Pastoralist Communities of Chad: Zoonoses, Morbidity and Health Services

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### **Note on earlier version**

The first edition of this publication was entitled *Human and Animal Health in Nomadic Pastoralist Communities of Chad: Zoonoses, Morbidity and Health Services*, PhD thesis, University of Basel, Swiss Tropical Institute. The thesis was written under the supervision of Dr. J. Zinsstag and Prof. M. Tanner (University of Basel) and Prof. J. Nicolet (University of Bern), and was accepted by the Philosophisch-Naturwissenschaftliche Fakultät der Universität Basel in 2002. The full version of the PhD thesis can be downloaded from:

[http://pages.unibas.ch/diss/2002/DissB\\_6478.htm](http://pages.unibas.ch/diss/2002/DissB_6478.htm)

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### **Cover Photos**

Left: camel herds gathering around natron wells in Northern Kanem Province, Chad. Middle: early morning in a nomad pastoralist camp in Chad. Right: Fulani women next to their tent and cooking space. (Photos by Esther Schelling)

### **Distribution**

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# 1 Summary

The health of nomadic pastoralists is influenced by factors specific to their way of life. Nomadic pastoralists depend on their livestock for subsistence, especially on the livestock's milk. Veterinary services provide vaccination against feared livestock diseases such as anthrax. Agents transmissible between livestock and humans (zoonotic agents) may have an important impact on the health status of pastoralists because they live in close contact to their animals. However, morbidity of nomadic pastoralists in Chad had not been documented and their everyday use of health services was virtually unknown. A research collaboration between veterinary and public health was implemented to evaluate morbidity of nomadic pastoralists and of their animals simultaneously and to test intersectoral pilot-interventions following the concept of "one medicine". The studies encompassed in this thesis were conducted in the framework of an interdisciplinary research and action programme.

Fulani and Arab cattle breeders and Arab camel breeders were visited during three consecutive samplings, two in the dry season and one in the wet season, between April 1999 and April 2000. A physician clinically examined 1160 women, men and children and completed a survey questionnaire. Sera, sputum and urine samples were collected from humans, as well as sera and milk from 1640 animals. Complementary interviews mainly directed at livestock health were recorded.

Brucellosis and Q-fever were selected to investigate a possible correlation between the occurrence of these zoonoses in livestock and in humans. No active foci of brucellosis were found. The impact of brucellosis and Q-fever on the health status of the three nomadic communities included in the study appeared marginal in comparison to other diseases recorded. Pulmonary diseases were frequent, e.g. bronchitis in children under 5 years of age (18%). Arab cattle and camel breeders were severely diseased by malaria during the wet season. Clinically diagnosed malaria was prevalent during the entire year among Fulani, who stayed in the vicinity of Lake Chad. Human serum retinol concentrations were significantly correlated to livestock milk retinol, illustrating the significance of milk as a dietary component. However, serum retinol levels of women were generally low. A 24-hours dietary recall showed that nomadic pastoralists only rarely consumed fruits and vegetables.

The utilisation study provided an overview on health service utilisation patterns of sick nomadic pastoralists. Participants with respiratory disorders went early to a dispensary for consultation and successively also used more other health services. Dispensaries where anti-malarial drugs were known to be in short supply were rarely visited during the wet season. Our data suggest that young unmarried women and men had fewer opportunities to visit a marabout or a dispensary than other members of the community. Women gave birth assisted by relatives in the camps, and prenatal health care was virtually not used. No fully immunised nomadic child was found in the study population. In contrast, livestock had been vaccinated by veterinarians visiting the nomadic camps during compulsory vaccination campaigns. Breeders observed an increasing inefficacy of anthrax, blackleg and pasteurellosis vaccines. Deaths of cattle after vaccination

against contagious bovine pleuropneumonia and visits of veterinarians solely to take blood for rinderpest serosurveillance without treating diseased animals were recurrent complaints of nomadic pastoralists towards veterinary services. Nevertheless, the idea of joint human and animal vaccination campaigns was appreciated because nomadic pastoralists wanted vaccination for their children, especially against measles. To which extent knowledge and experiences with livestock vaccination were transposed to children vaccination remained unclear. A cost analysis of subsequent joint vaccination campaigns showed that the public health sector can save up to 15% of infrastructure and personnel costs when vaccination services for nomadic children and women are delivered together with interventions of the livestock production sector.

Improvement of the quality of dispensary services has a potential to increase the utilisation of dispensaries by nomadic people. Health workers belonging to the nomadic community itself and better able to reach the camps may, nevertheless, be more accessible to women and children. Static or outreach dispensary-based vaccination services do not have the same efficiency to reach nomadic children as mobile vaccination campaigns have. Private veterinarians, who almost exclusively have access to pastoralists in remote areas would be interested in more fully capitalising their transportation infrastructure. Joint human and animal vaccination campaigns should be extended to other services (such as the selling of drugs) and especially to information campaigns. The provision of appropriate information may be as important as health care interventions themselves.

## 2 Introduction

### 2.1 Context

When the Swiss Tropical Institute initiated a new interdisciplinary research and action programme in nomadic pastoralist settings of Chad, veterinarians were asked to contribute to a project research protocol at the interface of human and animal health. The interrelationship between nomadic pastoralists and their livestock is far-reaching. Transactions involving property and services, as well as social events such as weddings, are commonly realised through exchange of livestock. Besides providing nomadic pastoralists with their only source of subsistence, livestock are also an aesthetic pleasure, leading to a sense of well-being and a basis of wealth and respect for pastoralists. Different studies, drawing on the disciplines of geography, anthropology, biology, veterinary and human medicine, and microbiology were set-up to provide data on transhumance routes, utilisation of health services, perceived health priorities, ill-health, and morbidity of nomadic pastoralists in two Sahelian provinces of Chad.

### 2.2 Nomadic pastoralism and morbidity

The ecological and anthropic parameters are dynamic and constantly changing in pastoral settings of Africa. The total number of mobile pastoralists in Africa is not defined. Bonfiglioli and Watson (1992) have estimated that mobile breeders constitute 16% of the Sahelian population. In many Sahelian countries, however, a shift is recognised from traditional breeding systems – mobile for the most part – towards herds owned by sedentary people who no longer support an entire pastoralist family (Thébaud, 1992). The exclusion of pastoralists from more productive pastures (with higher agronomic potential) by farmers, and blocking of traditional transhumance routes, lead to significant disruption of the annual transhumance cycle, thus increasing the ecological and economic vulnerability of pastoral systems in dryland Africa. Warm arid ecosystems – typical pastoral zones – are characterised by variability, unpredictability, and high resilience, and, therefore, land-use patterns for livestock breeding must adapt to the variability and uncertainty of rainfall using “opportunistic”, flexible and mobile strategies (Niamir-Fuller, 1999). The drier the ecosystem, the more incentive there is to manage natural resources communally in order to minimise individual risk. Diversification of livestock species, herd splitting with animals raised in separate places, and herd loans are strategies for reducing or distributing the risks of livestock losses due to epidemics or environmental constraints (scarcity of dry season grazing and water supplies, degree of flooding during rains, and prevalence of insect vectors) (Fratkin and Smith, 1994). Pastoralists lag behind sedentary people in education in most African countries, leading to a lack of representation in governmental institutions and thus often a lack of political empowerment (Majok and Schwabe, 1996). Informal rules between pastoralists and the settled population could be translated into formal Codes of Law, backed by new state institutions, in order to prevent their disappearance. However, this may not be an easy

task, as there is a danger of binding them into too static a structure, and therefore not allowing them to adapt to changing needs (Lachenmann, 1991).

The preferred food of all pastoral populations is milk and its products. Cereal is the most important staple food. In East Africa, pastoralists appear to be close to the lower threshold of reasonable nutritional status at most times – their diet being low in energy, but adequate in protein (Galvin, 1994). Sugar has become an important new source of energy for pastoralists (Holter, 1988). Much of the research on African pastoral production has focussed on problems of drought (and economic development) (Fratkin et al., 1994). In the Sahel, the critical period in terms of adult and child nutrition among pastoralists is often the end of the dry season, characterised by reduced livestock milk production, high temperatures and aridity, and increased energy expenditure associated with pasturing and watering herd animals (Nathan et al., 1996).

Zoonotic infections, transmissible between humans and animals, are closely associated with pastoralism. Worldwide, zoonoses have important impacts on public health and livestock economies. Taylor et al. (2001) reported 868 zoonotic infections representing 61% of all infectious organisms known to be pathogenic to humans. Vertebrate animals (including humans) are the reservoirs of zoonotic infections, and disease agents (bacterial, rickettsial, viral, parasitic and fungal) are transmitted directly or indirectly between them. Transmission of pathogens from livestock to pastoralists may occur, for example, through consumption of uncooked milk or through obstetric work. Humans are not likely to be infected with infections such as anthrax, rabies or brucellosis if the disease does not occur in livestock. Therefore, livestock or pet animal vaccination against anthrax and rabies, as well as brucellosis eradication programmes, are also public health measures.

Swift et al. (1990) and Loutan (1989) identified five main factors affecting morbidity patterns in nomadic pastoralists: i) proximity to animals, ii) problems related to a diet rich in milk, iii) mobility and dispersion, with subsequent difficulties in getting and maintaining treatment, iv) factors related to the special environment (hot, dry and dusty zones), and v) socio-economic and cultural factors, as well as the presence or absence of traditional healers. Migration may put nomadic pastoralists at periodic risk of infection, especially around water points (Rahmann, 1996). The health status of nomadic pastoralists in the Sahel in terms of morbidity and mortality is not well defined. A few analytical studies on morbidity have compared the frequency of selected diseases among settled agropastoralists to that among nomadic pastoralists (Hilderbrand, 1985; Chabasse et al., 1983).

Knowledge about everyday use of health services by nomadic pastoralist populations is insufficient. Little experience exists in providing health services to nomads, and only few evaluations of innovative services for nomadic communities have been performed (Swift et al., 1990). Nomads are known to be vulnerable to exclusion from primary health care and education systems (Sheikh-Mohamed and Velema, 1999; Aliou, 1992 and 1995; Omar, 1992). In contrast to public health services, pastoralists have decades of experience with livestock vaccination provided by veterinary services.

### 2.3 The concept of “one medicine”

The concept of “one medicine” was promoted by the American epidemiologist Calvin Schwabe in the 1960s. It describes the intrinsic link between human and veterinary medicine. Western human and veterinary medicine share most of the same paradigms; they have their roots in biology, and both contribute to “general medicine.” Both are dependent on a common pool of knowledge in anatomy, physiology, pathology and aetiology of diseases (Schwabe, 1984). The roots of this concept can be traced historically. During the 20th century, both disciplines became increasingly specialised fields.

The practical side of the “one medicine” concept goes beyond the control of zoonoses, food safety, and disease surveillance. It proposes to join veterinary with human health services in order to control important public health diseases. Health education and training, first aid, and joint vaccination services could be other branches of collaboration between the two sectors (intersectoral operational collaboration). Wherever single approaches cannot be used (mainly due to financial constraints), all potentially multiuse facilities, personnel and routines of veterinary, education, human health, water and environmental services could be actively shared. Majok and Schwabe (1996) state that veterinarians are the most extensively distributed form of manpower with higher degrees of education, and that they are likely to reach livestock owners in most rural areas. When pastoral families can be reached, maximum use should be made of each visit. Yet so far, only few integrated human and veterinary health care interventions have been documented (Ward et al., 1993).

### 2.4 Objectives of the study

The main objectives of the present study were to identify the predominant health problems among nomadic pastoralists and their livestock in Chad, with a special focus on zoonoses, and to assess their expectations from public health and veterinary services, in order to design and evaluate joint human and animal health strategies adapted to mobile populations. This included:

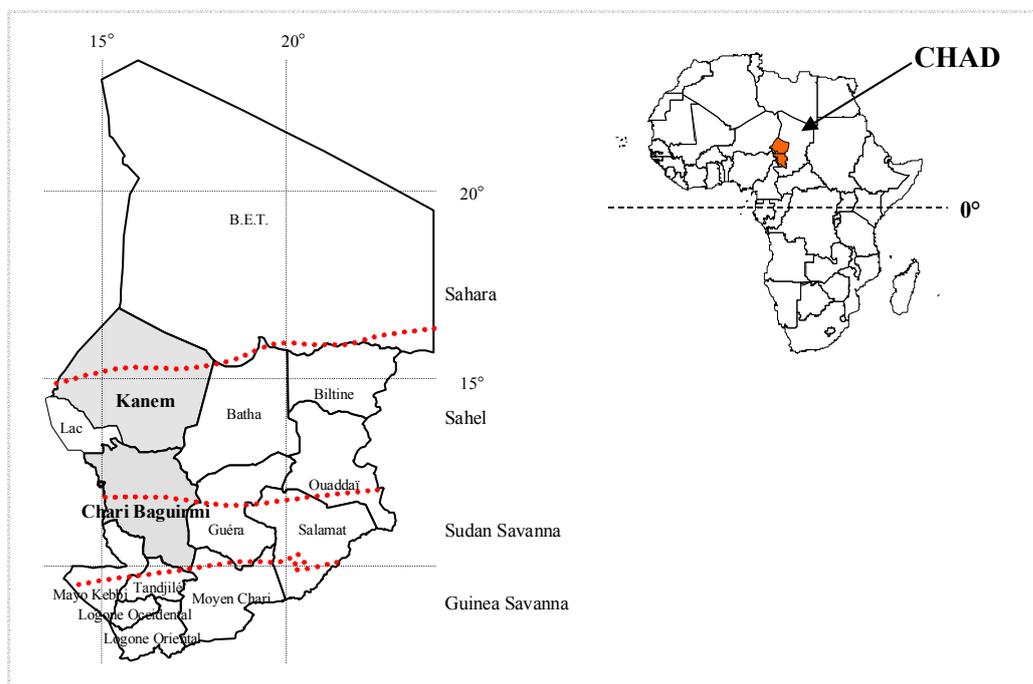
- Assessment of selected zoonoses in humans and livestock, and identification of risk factors for infection of nomadic pastoralists
- Description of human and animal diseases that occur, according to season and breeding systems
- Evaluation of health services and their utilisation by nomadic pastoralists
- Comparison between perceived illnesses and biomedical results
- Evaluation of pilot interventions in nomadic settings



## 3 Approach

### 3.1 Study site

The study zone in the Chari-Baguirmi (north) and the Kanem (south) is typical of the Sahel zone. The Sahel has average annual rainfall of around 400 mm (100 mm near the Sahara and 700 mm near the Sudan Savanna), which is largely concentrated in a single wet season. Officially, 11% and 4.4% of the rural population of Chari-Baguirmi and Kanem, respectively, are nomads. These numbers are likely underestimated, as the census was conducted in a period when many Fulani were in Cameroon, and as a certain proportion of the nomads were likely to have been missed in the fields.

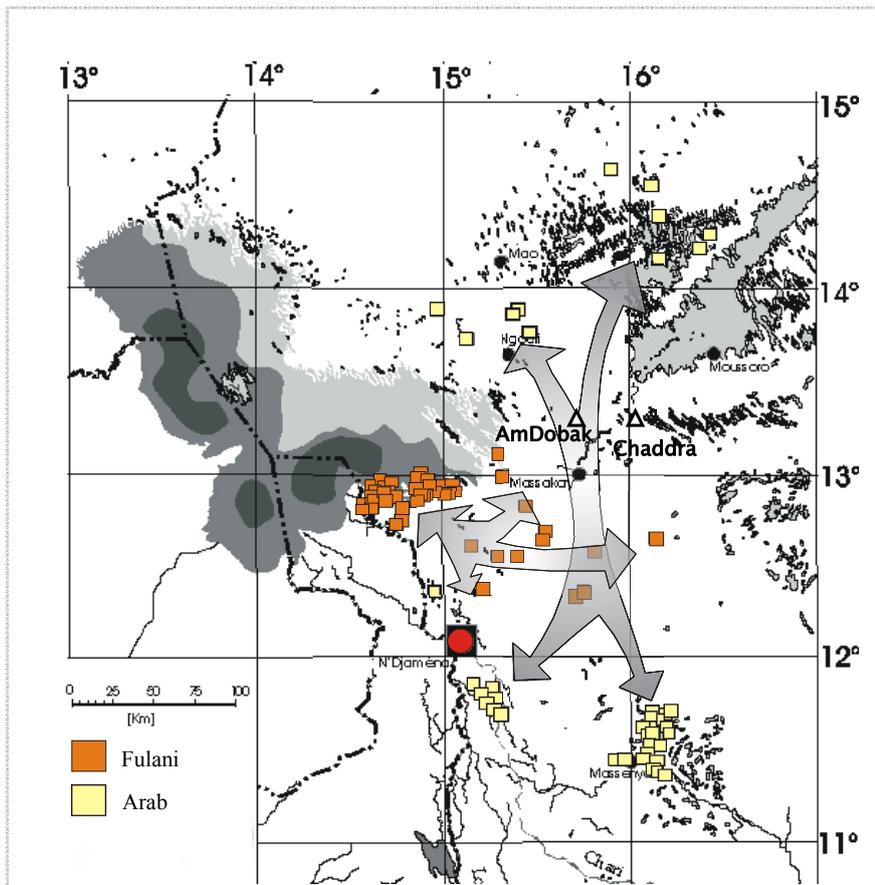


**Figure 1:** The two provinces of Chari–Baguirmi and Kanem in Chad. The approximate borders of the Sahara–Sahel, Sahel–Sudan Savanna and Sudan Savanna – Guinea Savanna zones are indicated.

### 3.2 Nomadic communities

Nomadic Fulani cattle breeders and Arab camel or cattle breeders were chosen in order to include two different ethnic groups and the two main types of livestock kept. During the wet season, Fulani cattle breeders leave the zone of lake Chad mainly because the pastures at the shore or on the islands are flooded, but also to take advantage of fresh green pastures. They use surface water in the clay plains of Chari-Baguirmi. As soon as the rain stops, approximately three months later, they hurry back to the lake to arrive before access is blocked by cultivated fields. Most Fulani families engage in some agricultural activity themselves, and a small portion of the Fulani in the lake Chad region are in transition to semi-nomadism, practising some agriculture or engaging in small-

scale business, while retaining transhumant livestock breeding as the basis of their economy (Planel, 1996). Arab camel breeders leave the zone of the Massenya flood plains (Chari-Baguirmi) after the first rainfalls, and move about 400 kilometres northwards to disperse in the Kanem within three months. In the Kanem, they stay in remote zones far from villages. Arab cameleers came to the Chari-Baguirmi from Central Chad only after the last severe drought in 1985, and after the civil war. In the Chari-Baguirmi and Kanem, they faced severe problems with access to wells, due to lack of traditional access rights. They are very rarely involved in agricultural activities. Younger men herd young and non-lactating camels separately, while lactating camels remain with the family. The Arab cattle breeders were the most heterogeneous group with regard to sub-ethnic background. They do not move as far north with their cattle from the Massenya (Chari-Baguirmi) zone as the cameleers. Some camps stay all year in the flood plains of Massenya, while only the young men go north with the small ruminants and cattle. In contrast to camel breeders, they have already been in this zone for about fifty years. Some Arab cattle breeders collect Arabic gum, which they sell for a high profit on the markets. All three nomadic pastoralist communities are Muslim. Their transhumance routes, socio-economic features, and socio-cultural relationships are detailed in Wiese (2002).



**Figure 2:** Location of nomadic camps visited in northern Chari-Baguirmi and southern Kanem (map layer by M. Wiese)

### 3.3 Sampling

With the help of nomad representatives, camp elders were contacted randomly. They were asked to participate in the study after being informed about its objectives and the sampling procedure. From an initial list including the names of camp elders willing to participate, a second selection was made randomly. A unique identification number was allocated for each camp visited, which was retained for all samplings. Sixteen Fulani and 15 Arab camps were visited during a first sampling in May/June 1999 (hot dry season). Twenty-seven of these camps were visited again during a second sampling in October/November 1999, after the annual rainy season. During this period (wet season), Fulani and Arabs are involved in long transhumance movements. During a third sampling in March/April 2000, six Fulani and four Arab camps were visited for a third time. In addition, 12 Fulani and 11 Arab camps were newly included in the study.



## 4 Results

### 4.1 Brucellosis and Q-fever seroprevalences among nomadic pastoralists and their livestock in Chad

The relationships between the seroprevalences of brucellosis and Q-fever in humans and livestock were evaluated in three nomadic communities in Chad (Fulani cattle breeders, and Arab camel and cattle breeders). Nomad camps were visited between April 1999 and April 2000. A total of 860 human and 1637 animal sera were tested for antibodies against *Brucella* spp., and 368 human and 613 animal sera for *Coxiella burnetii*. The same indirect ELISA was used for livestock and human sera, and the test characteristics for its use on human sera were evaluated. Twenty-eight people were seropositive for brucellosis (seroprevalence 3.8%). *Brucella* seroprevalence was higher in cattle (7%) than other livestock, and brucellosis seropositivity was a significant factor in abortion in cattle (OR = 2.8). No correlation was found between human brucellosis serostatus and camp proportions of seropositive animals. Q-fever seropositive blood samples were taken from 11 Arab camel and 4 Arab cattle breeders (seroprevalence 1%). Being a camel breeder was associated with Q-fever seropositivity in humans (OR = 9). Camels had the highest Q-fever seroprevalence (80%) among livestock species. Although there was high-risk human behaviour for the acquisition of brucellosis and Q-fever from livestock through raw milk consumption (98%) and contact with livestock placentas (62%), we concluded that seroprevalences in humans were relatively low, likely due to limited active foci in livestock.

### 4.2 Serum retinol among Chadian nomadic pastoralist women in relation to livestock milk retinol and $\beta$ -carotene content

Human serum retinol and livestock milk retinol levels were assessed as part of a study on the health status of Chadian nomadic pastoralists and their livestock, in close partnership with Chadian public health and livestock institutions. Of the women examined (n = 99), 43% (95% CI 33 – 54 %) were deficient ( $0.35 \mu\text{mol/L} < x < 0.7 \mu\text{mol/L}$ ) and 17% (95% CI 10 – 26 %) severely retinol deficient ( $<0.35 \mu\text{mol/L}$ ). None of the women interviewed (n=87) reported the consumption of fruit, and only two reported consuming fresh vegetables in the past 24 hours. Milk is the almost exclusive source of vitamin A for these populations. Goats (n=6) had the highest average milk retinol level [ $329 \pm 84 \mu\text{g/kg}$  (mean  $\pm$  SEM)], followed by cattle (n=25;  $247 \pm 32 \mu\text{g/kg}$ ), and camels (n=12;  $120 \pm 18 \mu\text{g/kg}$ ). Milk retinol levels did not differ between the rainy and dry seasons. Human serum retinol depends significantly on livestock milk retinol levels (partial slope 0.23; 95% confidence interval 0.008 – 0.47). Our study supports the use of goat and cow milk as an important source of vitamin A in pastoral nomadic settings. However, these levels still need to be complemented further by promoting green leafy vegetables, fruits and supplements.

### 4.3 Morbidity and nutrition patterns in three nomadic pastoralist communities in Chad

Morbidity and nutritional patterns were assessed in three nomadic communities of Fulani and Arab cattle breeders in two prefectures in Chad. The predominant morbidity pattern of Chadian nomadic pastoralists (representing approximately ten percent of the total population of the country) had not been documented so far. A total of 1092 women, men and children were examined by a physician and interviewed during two surveys in the dry season and one in the wet season (1999-2000). Participants with no complaints were rare. Pulmonary disorders (e.g. bronchitis) were most often diagnosed for children under five years of age. Of the adult participants, 4.6% were suspected of having tuberculosis. Febrile diarrhoea occurred more often during the wet season, when access to clean drinking water was precarious. Malaria was only rarely clinically diagnosed among Arabs during the dry season, whereas Fulani, who stayed in the vicinity of Lake Chad, were also affected during this period. A 24-hour dietary recall showed that less Arab women than men consumed milk during the dry season (66% versus 92%). Malnutrition was documented for only 3 of 328 children (0–14 years). Arab women of childbearing age had a higher proportion of non-surviving children compared to Fulani women (0.2 versus 0.07), which points up the heterogeneity among nomadic communities. However, innovative and adapted health services for nomads can possibly be extended to many settings, as nomadic pastoralists have in common a similar way of life driven by the needs of their animals.

### 4.4 Utilisation of health services in three nomadic pastoralist communities in Chad

In Chad, nomadic pastoralists rarely visit health dispensaries, or do so only in an advanced stage of disease. Yet patterns of health services used by nomadic pastoralists were virtually unknown. In order to assess generalities and differences among nomadic communities regarding health care utilisation, 1116 survey questionnaires were completed in three nomadic groups (Fulani and Arab cattle breeders, and Arab camel breeders) during two surveys in the dry season and one in the wet season. Utilisation patterns according to age class, sex, group and season were analysed for participants reporting specific symptoms or presenting defined affections (as diagnosed by a physician). Vaccination status of children and women and use of prenatal health care were recorded. Multiple services, traditional and Western, were used. Apparent differences in health service utilisation between communities were mostly due to less common use of dispensaries and traditional healers by both Arab camel and cattle breeders, but Arab cameleers consulted a *marabout* more often than Fulani. Dispensaries were visited by one fourth of sick participants, with no significant differences between sexes. Participants with respiratory disorders went early to a dispensary for consultation, and successively also used more other health services. During the wet season, use of health services was dominated by the high frequency of malaria occurrence. Dispensaries where anti-malarial drugs were known to be in short supply were visited less often. Our data suggest that young unmarried women and men had fewer opportunities to visit a *marabout*.

*bout* or a dispensary than other group members. No fully immunised nomadic child was found in the study population. Women gave birth assisted by relatives in the camps, and prenatal health care was virtually unused.

#### **4.5 Nomadic pastoralists' perceptions of future joint human and animal vaccination campaigns**

Nomadic pastoralists of Chad have had experience with livestock vaccination for decades. In contrast to livestock, nomadic children were not vaccinated. We proposed that mobile veterinary infrastructure could be extended for simultaneous vaccination of children in nomadic groups. Yet the experiences of pastoralists with existing vaccination services, and their considerations of feasibility and planning of joint vaccination services, appear to be crucial for sustainable implementation. Their attitudes were evaluated in over 100 interviews conducted with Fulani cattle breeders and Arab cattle or camel breeders in two provinces of Chad. Pastoralists did not always carefully distinguish treatment from prophylaxis (vaccination). This was emphasised by their wish to have their livestock vaccinated when the animals were most diseased (i.e. in the wet season). The quality of livestock vaccines was heavily questioned, and therefore many pastoralists did not want their cattle to be vaccinated as a part of compulsory vaccination campaigns. Few breeders knew about the existence of vaccination for children, although measles were feared. The idea of joint vaccination campaigns was appreciated. Besides demands for vaccination for their children, pastoralists also desired more information on child vaccination. How much information from livestock vaccination is extrapolated to child vaccination remains unclear. Pastoralists recommended that information on future campaigns be propagated by radio broadcast. Once the period and zone of vaccination are known, pastoralists would be willing to organise the regrouping of several camps to one vaccination site. This site would need to be in the surroundings of the camps to ensure enough water and pasture. Furthermore, campaigns should be well organised to limit time investment by pastoralists, and drugs for humans and livestock should be offered simultaneously.

#### **4.6 Cost sharing through joint human and livestock vaccination campaigns among nomadic pastoralists in Chad**

The vaccination rate of nomadic pastoralist children and women was zero in two districts of Chad at the beginning of the study. In contrast, livestock had been vaccinated by veterinarians visiting the nomadic camps during compulsory vaccination campaigns. Joint human and livestock vaccination campaigns were initiated to reach nomadic children and women who so far had not been covered efficiently by the National Expanded Programme on Immunization (EPI). In zone A (Gredaya), 3 out of 6 vaccination rounds were conducted in common with the veterinary sector, but in zone B (Chad-dra/AmDobak) only one out of 6 rounds was performed together with veterinary services. Data for cost analyses of these vaccination campaigns were collected and all

costs were allocated to the public health and/or livestock production sectors. Follow-up rates for individuals strongly influenced the costs per fully immunized child (FIC) and per tetanus vaccinated woman (TT2+). Vaccine costs accounted for the bulk of the costs in the public health sector. Of the total public health costs for vaccination, 6.7% and 2.8% were shared in zones A and B, respectively. Considering only personnel, transportation and cold chain costs, these proportions increased to 15.1% and 4.1%, respectively. For zone A, costs per FIC (US\$ 10.7) were comparable to costs calculated for an outreach vaccination service (US\$ 12.5). The costs per FIC were considerably higher in zone B (US\$ 27.2). In many remote areas in Sahelian countries, veterinarians almost exclusively have access to pastoralists. Private veterinarians would be interested in more fully capitalising on their transportation infrastructure by participating in campaigns including public health aspects.

## 5 Discussion and Conclusions

### 5.1 Interdisciplinary research and participatory approach

The successful realisation of this study would not have been possible without the professional input of the Chadian research partners. Furthermore, their knowledge of local premises, customs, traditions and languages was indispensable for the organisation of the project. North-South collaboration from an early planning stage onwards was extremely beneficial.

The strength of epidemiological approaches is to show general patterns, to compare groups in order to identify the sub-groups at highest risk, and to test hypotheses. However, it tends to focus on a limited number of parameters. Studies at the individual level allow for a deeper appreciation and understanding of a community. This emphasis on the individual may render recognition of general influences difficult. Therefore, both epidemiological and anthropological vulnerability approaches are necessary to better understand the target population and the complexity of issues involved. Only interdisciplinary (systematic) research approaches make it possible to gain in-depth and pertinent knowledge about communities (Weiss, 2001).

Specifically, important public health diseases may not be perceived as such by the community (e.g. zoonoses) – and vice versa. Illnesses perceived as important should be integrated in health care provision programmes. Treatment-seeking behaviour may be influenced by cultural norms, e.g. the Fulani concept of *pulaaku*, encompassing a high degree of self-control, may result in the use of health services only at an advanced stage of disease (Krönke, 2001). Furthermore, vulnerability related to spatial, social, political-economic and ecological factors significantly influences access to health services (Wiese, 2002).

The term “participation” is widely used, but in the absence of a precise definition it is used in relation to different processes. A participatory planning process to design interventions would involve the target community from the initial planning phase onward, to final evaluation. In our case, the sector of action was predefined; however, access to water and education, security issues, or the health of their livestock may have equal or higher priority for nomadic pastoralists than their own health (Wiese, 2002). A rapid assessment at low cost could be directly used to plan interventions (Vlassoff and Tanner, 1992). But directly applicable results that can immediately be transformed into action may be obtained only late with such approaches, especially in the nomadic context (Randall, 1994). Desirable changes will most likely be possible in small steps by taking advantage of, and grafting any new efforts and ideas upon, traditional beliefs and institutions. This will only be achievable if pastoralists participate at all stages (Wyss, 1998).

## 5.2 Implications for further research and health service interventions

Earlier reports showed high brucellosis seroprevalences (up to 30%) in Chad (Domech et al. 1982). No active foci of brucellosis infection were found in this study, which was conducted in a dryer zone than previous studies. More strains of *Brucella* spp. should be isolated to determine active foci of brucellosis. *B. melitensis* occurrence needs to be further evaluated by strain isolation and characterisation, especially in cattle and camels. A high Q-fever seroprevalence among camels, such as that found in this study (73%), had not been reported in the literature so far. Being a camel breeder was a significant risk factor for Q-fever seropositivity in humans. Seventeen percent of cattle were tuberculin positive; therefore, bovine tuberculosis is suspected of representing another health hazard for pastoralists. The importance of bovine tuberculosis in humans should be determined through isolation and characterisation of *Mycobacterium tuberculosis* and *M. bovis* strains from human and animal specimens. Cooking milk before consumption could prevent zoonotic infections such as brucellosis, Q-fever and tuberculosis in nomadic pastoralists, and also prevent the sedentary population from buying their milk from pastoralists. For an efficacious communication of the importance of cooking milk, information about disease transmission by germs will need to be introduced first.

Digestive disorders were the most important disease class, and included mainly parasitoses and gastritis, with fewer cases of diarrhoea (in total 5% of participants). Pulmonary affections were frequent, e.g. bronchitis in young children (18%). A comparative study on morbidity and nutrition patterns between nomadic pastoralist and sedentary communities would shed light on whether the morbidity pattern found is distinct from that usually found in rural African settings.

Although Fulani and Arab women reported comparable birth rates, Fulani women reported more children alive. The overall proportion of lost children was 0.2 for Arab women of childbearing age but only 0.07 for Fulani mothers. These indicators are important information for the definition of research priorities and of appropriate health policies for nomadic people. Further research on child mortality (with detailed life histories of deceased children) and child care is necessary, but maternal periparturial complications, management of child birth difficulties, and family planning should also be evaluated in-depth. Women gave birth assisted by relatives in the camps, and prenatal health care was virtually not used. Randall (1994) states that nomadic women are assisted by other women at parturition and, therefore, it may be more reasonable to give short-term training to many nomadic women than to give extended training only to a few birth attendants.

Human serum retinol concentrations were significantly correlated with livestock milk retinol, illustrating the significance of milk as a dietary component for Chadian nomadic populations. In accordance with Holter (1988), fruits and vegetables were rarely consumed among pastoralists in the three communities studied. The promotion of green vegetables and fruits as nutrition supplements for adults, and especially for infants and young children, should be incorporated in health information campaigns.

The initiation of the “Health for Nomads” programme derived from the observation that nomadic pastoralists rarely visit the dispensaries of Chari-Baguirmi, or do so only in an advanced stage of disease. Dispensaries in rural Chad often lack adequate infrastructure, drugs, quality services, and supervision. When availability of drugs and vaccines is reduced at dispensaries, nomads are likely to be discriminated against and excluded from treatment of vaccination first. Dispensaries were visited by one fourth of “diseased” participants, but dispensaries where anti-malarial drugs were known to be in short supply were visited less often. Improvement in the quality of dispensary services (including an adequate stock of western-type drugs, reduction of waiting times and accommodations for relatives to stay with hospitalised patients) appear to have a potential to increase the use of dispensaries. Fulani complained that people in charge of dispensaries did not know their illness (Krönke, 2001). Providing dispensaries with a list and descriptions of Fulani illnesses, as well as information about the constraints of nomads in general, may also improve quality and acceptance. A serious problem remains the treatment of ailments such as tuberculosis and venereal diseases, which need continuous drug treatment over longer periods at a dispensary level. A directly observed treatment short course (DOTs) for tuberculosis, adapted to nomadic populations, has not been tested so far. Nomadic community health workers (CHW) and female birth attendants have the great advantage of living closer to and reaching the camps and thus they may be more accessible than outside practitioners. We found that information on human and livestock diseases, their treatment, and transmission was actively sought by nomadic pastoralists. Besides general health messages, information on dispensary services, their costs, and on efficient home remedies, could be included in discussion platforms. The transmission of appropriate information may be as important as health care interventions themselves.

Pastoralists in Chad have lost much confidence in veterinarians and their abilities during the last few years. After the success of rinderpest eradication, pastoralists observed an increasing inefficacy of anthrax, blackleg and pasteurellosis vaccines. Nomads’ comments on the inefficacy of anthrax and other livestock vaccines should be addressed by quality control of vaccines. Deaths of cattle after vaccination against contagious bovine pleuropneumonia, and visits of veterinarians solely to take blood for rinderpest serosurveillance without treating diseased animals, were recurrent complaints about veterinary services. In contrast to frequent contacts to veterinary services, exposure to vaccination services for children was rare. No fully immunised nomadic child was found during the morbidity study. We found that the existence of vaccines against measles was known, but pastoralists were distinctively less aware of other vaccines for women and children. Fewer breeders knew about the existence of child vaccination at all, although measles were well known and feared. Arabs especially demanded better access to measles and whooping cough vaccination. These two diseases ranked second and seventh, respectively, among illnesses perceived as causing the most harm among Fulani (Krönke, 2001). The extent to which knowledge and experience with livestock vaccination were transposed to child vaccination remained unclear. This has interesting implications for further research to systematically evaluate interactions between animal and human health through use of better-adapted research tools.

As part of an action programme that resulted from consultations among various stakeholders, joint vaccination campaigns were conducted. To our knowledge, costing of an intersectoral vaccination approach had not been done so far. Significant differences in costs per fully immunised child were found between Gredaya and Chaddra/AmDobak, mainly due to distinctly higher total numbers of children and women reached per day and more vaccination rounds with veterinary services in Gredaya. In the zone of Gredaya, joint campaigns allowed the public health sector to save 7% of total costs (including vaccine costs) and up to 15% of infrastructure and personnel costs. Static or outreach dispensary-based vaccination services do not have the same efficiency in reaching nomadic children as mobile joint vaccination campaigns. Performance analysis of joint vaccination campaigns should provide data on the quality of vaccination services, vaccination coverage (using capture-recapture methods), access (or exclusion) of nomadic communities to joint vaccinations, cost-effectiveness, and cost-benefit for the public health and livestock sector. Such studies would be crucial in view of possible extension of joint vaccinations to other sites and countries.

### 5.3 Inequalities in health between and among nomadic and sedentary communities in Chad

Health care is not limited to providing curative services but also includes health promotion, disease prevention, rehabilitation and cure (Declaration on “Health Care for All”, Antwerp, 2001). Egalitarian reasons justify efforts to develop innovative and adapted health services for nomadic people who are known to be vulnerable to exclusion from primary health care. Otherwise, is the sedentary rural population better off in terms of health and access to health services than nomadic pastoralist communities? We postulated that the sedentary population would have better access to health services than the marginalised nomadic population. The present thesis was designed to compare the health status of different nomadic communities and not to compare it to settled rural populations.

Health inequality is a distinct dimension in the performance of a health system, and may be defined as variations in the health status of individuals in a population (Gakidou et al., 2000). Health inequalities usually do not convey any message about fairness in the differences in health between groups, as implied by the term “inequities” (Mackenbach and Kunst, 1997). There is a lack of consensus on indicators to describe the magnitude of health inequalities. Morbidity and mortality rates among different socio-economic and ethnic groups are often used. Relative and absolute poverty are important factors, based on strong evidence of inequalities in health status and access to health service between the poorest and richest quintile of the population in most countries (Gwatkin, 2000). However, others feel that a broader focus should be chosen, since inequality concerning social disadvantages not only relates to poverty. Gender-specific, socio-cultural and economic factors, ethnicity (ethnic minorities) and other factors such as geographical setting can worsen the adverse effects of poverty (Braveman, 2000; Gupta, 2000). Hill and Randall (1984) and Defo (1996) described the influence of ethnicity and maternal characteristics (particularly traditional practices such as nutritional

practices, and socio-economic factors including female education) on the health and survival chances of children in Sahelian countries.

Rural areas of Chad have higher under-five mortality rates than urban areas (204 versus 190 per thousand live births). Health care facilities are unevenly distributed in Chad, clustered in urban areas and scarce in poor rural zones. More than half of the rural Chadian population (three-fourth of the total population) is not effectively reached by the existing health services. Preliminary mortality rates for nomads obtained in this study are comparable to or lower than the Chadian average. Nomads had virtually never used vaccination or antenatal care services. However, overall vaccination or antenatal care coverage is also very low among the sedentary rural population. There is a need to establish some measures of health inequality in the rural Chadian population with more precision. The socio-economic model traces the roots of ill-health far beyond health services, to such determinants as income and education, as well as to infrastructure, environment and lifestyle. This model was supported by the political drive towards decentralisation, which made possible the collection of these data to determine resource allocation. In times of growing conflict between nomadic people and crop farmers, institutional aspects of resource management cannot be ignored. Community participation in primary health care to increase the effectiveness of interventions may be easier to achieve with a sedentary population than with a nomadic community. Nonetheless, health committees for and in nomadic communities should be established to define the tasks of a health programme and to take responsibility for it.

#### **5.4 Validation of the concept of “one medicine”**

The concept of “one medicine” has shaped most of our research questions for studies with nomadic pastoralists. We observed that a team offering medical care for both people and livestock was highly appreciated by pastoralists because it coincides with the logic of the pastoralists. This thesis has addressed the following topics at the interface of human and animal health: Transmission of selected zoonoses from livestock to pastoralists; nutritional aspects (milk consumption patterns and milk as a source of vitamin A); and health services (perception and implementation of joint vaccination services).

Few previous studies have examined the occurrence of a zoonotic disease simultaneously in humans and animals. Although the affected livestock species and vectors are well known for nearly all important zoonoses, their relative involvement in disease transmission to humans is not well studied. The sampling of pastoralists, together with different livestock species, revealed that cattle and camels were more important for brucellosis and Q-fever transmission, respectively, than small ruminants. These were unexpected results, which may be used for more focused control and information strategies. The acceptance of control measures is likely to be facilitated by communication of potential livestock production losses due to zoonoses.

Serum retinol (vitamin A) among nomadic pastoralist women correlated with livestock milk retinol levels. Thus milk was an important source of vitamin A. Provision of livestock products, namely of milk, can become critical when animals show reduced live

weight production, or several lactating cows or camels have reduced milk production due to suffering from disease or lack of enough water. Mothers sometimes minimise the impact of food shortages on children by reducing their own dietary intake and giving preference to feeding their children. The study period was satisfying for animal breeding (an increase in livestock body condition scores was documented), and milk was abundant. Only three protein-energy malnourished children were seen among all the nomadic pastoralist children examined (0-14 years, n=328). However, this situation may drastically change in a drought or severe disease situation.

Some specific human morbidity results could be explained by livestock breeding habits, e.g. camel breeders try to stay out of humid zones (especially zones with clay soils) to avoid arthropod-borne livestock diseases, but also to limit the risk of foot and leg fractures of their camels. Therefore, in contrast to cattle holders, camel breeders usually stay in a dry environment where they have low prevalence rates of clinical malaria. Their exposure to malaria infection is limited to a short period when rainfall is heaviest. This example shows that the community's capabilities to overcome ill health may be conditioned by the care they take of their animals.

Pastoralists more vividly acknowledge the success story of rinderpest eradication as a result of vaccination than the eradication of human smallpox, also obtained by vaccination programs. In contrast to vaccines against human diseases, pastoralists have long-term and continuous experience with livestock vaccination. One should build on existing knowledge of livestock vaccination to communicate the importance of vaccination for children and women.

The joint human and animal vaccination campaigns represent a novel intersectoral health services approach that has not been evaluated systematically so far. Cost sharing/saving between the two sectors was demonstrated, and health and veterinary personnel have welcomed the joint approach due also to its great appreciation among the pastoralists.

Further analyses of the significance of the socio-economic and psychological effects of zoonoses, the importance of food provision through livestock breeding, and the impact of human ill health on animal health and on the contribution of intersectoral collaboration to the strengthening of health systems, will help to review the framework of the "one medicine" concept in terms of promoting better health, social, and environmental outcomes.

## 6 References

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Esther Schelling wrote a thesis on the epidemiology of Newcastle Disease in Switzerland and subsequently earned a PhD in epidemiology at the Swiss Tropical Institute (STI), focusing on the health of nomadic pastoralists and their livestock in Chad. After doing a post-doc in the NCCR North-South, she joined the International Livestock Research Institute (ILRI) in Kenya as a joint appointment scientist of ILRI and STI. Her current research interests include the identification and testing of cost-effective control strategies for zoonoses to preserve the health and livelihoods of small-scale livestock producers and consumers of livestock products.

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The health of nomadic pastoralists is influenced by factors specific to their way of life. Nomadic pastoralists depend on livestock for subsistence, especially livestock milk. Veterinary services vaccinate against feared livestock diseases such as anthrax. Pathogens transmissible between livestock and humans (zoonotic agents) may have an important impact on the health of pastoralists because they live in close contact with their animals. However, morbidity among nomadic pastoralists in Chad has not been documented and virtually nothing is known about their everyday use of health services. Collaboration between veterinary and public health officials was implemented to evaluate morbidity among nomadic pastoralists and their animals simultaneously, and to test intersectoral pilot interventions according to the concept of “one medicine”. The studies encompassed in this thesis were conducted in the framework of an interdisciplinary research and action programme. Improving the quality of dispensary services has a potential to increase use of dispensaries by nomadic people. Health workers belonging to the nomadic community itself and better able to reach the camps may be more accessible to women and children. Static or outreach dispensary-based vaccination services do not have the same efficiency reaching nomadic children as mobile vaccination campaigns have. Joint human and animal vaccination campaigns should be extended to other public health and veterinary services and especially to information campaigns, since these campaigns are highly appreciated by the communities and the ministries and can save costs through inter-sectoral sharing of delivery infrastructure.

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