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Disease and dislocation: the impact of refugee movements on the geography of malaria in NWFP, Pakistan

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Abstract

Studies of the health implications of refugee movements have generally focused on the effects of dislocation on the health of refugees and the impacts on health care provision at the destination. A somewhat more neglected aspect of the refugee-health research has been the impact of refugee flows on the *geography* of disease, i.e., how the spatial patterns of disease prevalence are modified through the influx and settlement of refugee populations. We examine this issue by examining the changing geography of malaria in Pakistan's North West Frontier Province (NWFP) between 1972 and 1997. Until the late 1970 s, the highest incidence of malaria in the region was seen in the southern and eastern parts. During the 1980 s, however, two and a half million Afghan refugees entered the NWFP and were housed in tented villages along the border and in some interior areas. As the decade progressed, there was a significant shift in the spatial pattern of malaria, with the regions of highest incidence shifting to the west and north, coinciding strongly with refugee concentrations. Our study draws attention to the manner in which refugee influx and settlement can alter the ecology of the disease system, leading to long-term changes in the geography of malaria. © 2001 Elsevier Science Ltd. All rights reserved.

Keywords: Refugees; Health services; Migration; Malaria; Pakistan; Disease ecology

Introduction

Geographers and epidemiologists have long been aware of the close and recursive linkages between the spread of disease and human mobility (Curtin, 1968; Prothero, 1965, 1977; Wessen, 1974; Kamel, 1997). The act of migration, for example, can expose persons to health hazards during the journey and at the destination and make migrants passive acquirers. Alternatively, migrants can often spread a disease — often the very pestilence from which they were escaping — within the destination community by acting as active transmitters (Prothero, 1977). With the simultaneous rise in world population and human mobility, the imperative to learn more about the disease–mobility relationship has only increased.

A question of particular concern today relates to the health implications of refugee movements. As of January 1998, the number of forcibly displaced persons worldwide was 22.3 million, representing one out of every 264 people on earth (http://www.unhcr.ch/un&ref/un&ref.htm). A large and growing literature has drawn attention to the appalling health conditions experienced by refugees. Toole and Waldman (1990), for example, found that mortality rates amongst displaced persons, particularly the children, were significantly higher than the host country populations. Others discuss the conditions leading to this high mortality, including malnutrition (Boss, Brink & Dondero, 1987; Kliot, 1987), and the appalling conditions in refugee camps (Fuentes Aguilar, 1988; Suleman, 1988; Meek & Rowland, 1998). Finally, there has been much work focused on issues related to the delivery of health services to

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refugees (Black, 1991; Toole, 1994; Kamel, 1997; Kalipeni & Oppong ,1998), and specific issues related to health care of female refugees (Mayotte, 1992; Goodyear, 1997).

Whereas the previous body of literature has been instrumental in drawing attention to the health problems and needs of refugees, its focus on the refugees themselves has drawn attention away from a related issue of great concern, viz. the impact of refugee flows on the spatial patterns of disease prevalence. In the short term, the movement of displaced persons can, through its sheer volume, its contact with the local population, and its disruptive effect on health services, dramatically alter the geographic pattern of a disease. In the long term, the sustained presence of refugees and refugee camps can fundamentally alter the ecology of disease itself (Meade & Earickson, 2000). Thus, the links between refugee movements and disease go beyond the health conditions of the refugees themselves and can be fully understood only if we examine refugee impacts on the changing geography and ecology of disease.

Our paper examines these issues using the case study of malaria prevalence in the North West Frontier Province (NFWP) of Pakistan. Malaria is the most widespread of tropical diseases and a leading cause of mortality amongst refugees. In the 1980 s, the NWFP experienced a huge influx of Afghan refugees. Our study examines the manner in which this refugee incursion influenced the spatial patterns of malaria incidence in the region, and the long-term effects of the refugee incursion on the ecology of malaria in the NWFP. We begin with a background section that presents the disease ecology of malaria and the effect of refugees on the spatial patterns of the disease. This is followed by a discussion of Afghan refugees and malaria incidence in the NWFP. Our empirical examination of the geography of malaria in the NWFP is presented in the following section. The paper ends with a summary of our results and the conclusions of the study.

Background

The biology of malaria is well known and discussed elsewhere (Meade et al., 1998). Briefly, malaria is caused by a protozoan parasite (*plasmodium*). The four most commonly found parasites causing malaria in humans are the *plasmodium falciparum* (considered the most dangerous), *plasmodium vivax, plasmodium malariae*, and *plasmodium ovale*. The malaria parasite is injected into the human host by a vector, the *Anopheles* mosquito. The typical malaria cycle is as follows. The parasite enters the human bloodstream and travels to the liver where it grows and divides asexually. After a two-week period, the new daughter parasites enter the blood stream and invade the red blood cells. The parasites multiply and produce male and female gametes, and the first symptoms of malaria become apparent in the host. The next stage begins when blood containing the gametocytes is sucked out of the host by the *Anopheles*. The cooler conditions stimulate the fertilization of the female gamete. The resulting zygote develops within the body of the mosquito, ultimately producing parasite spores. The malaria cycle is completed when the feeding *Anopheles* reintroduces the *plasmodium* parasite into the human host (Dutta & Dutt, 1978).

While the *plasmodium* has little exposure to the external environment, and is relatively unaffected by external environmental conditions, the environment plays a crucial role in the ability of the *Anopheles* vector to transmit the parasite (Dutta & Dutt, 1978). The longevity of the female *Anopheles* is strongly related to the availability of food (viz. plant nectar and animal and human blood), temperature (excessive heat or cold lowers life span), and humidity (increasing humidity increases life span). Consequently, malaria flourishes in the tropical environments, particularly where poverty and weak health systems prevent effective intervention (World Health Organization, 1999).

Two types of malaria regions can be recognized: endemic and epidemic. Endemic malaria regions are those where the malaria incidence is fairly constant from year to year. Endemic regions with very high malaria intensities are commonly referred to as stable endemic regions while those with moderate intensities with seasonal fluctuations are referred to as unstable endemic regions. Stable endemic malaria is primarily found in tropical Africa (except for the highlands) and Papua New Guinea. Unstable endemic malaria prevails across much of the rest of the tropical world, particularly in Asia and Central and South America. Epidemic regions are those that experience high but irregular malaria incidence related, for example, to seasonal population movements. Epidemics are generally uncommon in areas of stable endemic malaria because the population has attained partial immunity. In contrast, the collective immunity of the population is low in areas of unstable malaria, making these areas more vulnerable to epidemics. Consequently, epidemics are common in large parts of the Indian sub-continent, Middle East, South East Asia, Northwest Africa and South America.

In order to explore the links between the geography of malaria and refugee flows, it is useful to briefly discuss the general characteristics of refugees. The United Nations High Commission for Refugees (UNHCR) defines refugees as persons who reside outside their own country "owing to a well-founded fear of persecution, for reasons of race, religion, nationality, membership of a particular social group or political opinion" (UNHCR, 1998a). Regardless of the reasons for the displacement, refugee migrations usually have certain elements in common: refugees generally move on foot or a low-tech form of transportation (e.g., carts, boats) and travel without official documents or tangible property (De Blij, 1996). At the destination, while refugees are sometimes repatriated or dispersed in rural areas, the most common solution is to create temporary or permanent refugee camps. The common characteristics of refugee movements have important implications for the changing geography of malaria. Several short- and long-term impacts can be identified.

First, refugee movements bring about a relatively rapid transfer of persons from one type of malaria region to another, altering the rates of malaria incidence at the destination. For example, refugees coming from areas of marginal or unstable transmission and moving through or settling in stable endemic areas are likely to suffer most severely from high malaria incidence. In contrast, refugees moving from a stable malaria region into a region with low or moderate endemicity can act as passive transmitters of the parasite into a local population with relatively low immunity levels. This can lead to a full-blown malaria epidemic. If the ratio of refugees to the local population is high, this may even cause an unstable malaria region to become a stable malaria region (Prothero, 1995; Najera, 1996).

Second, refugees most often end up in refugee camps, described as amongst the most pathogenic environments imaginable. Refugee camps are densely populated, and characterized by poor sanitation and contaminated food and water. The overcrowding increases the risk of human–vector contact. Pits dug to provide latrines or to excavate earth for shelter construction trap standing water creates new breeding grounds for the *anopheles* vector. Contact between humans and the vector is also increased because the areas surrounding a refugee camp is usually stripped of vegetation thus offering few resting-places for mosquitoes. Taken together, the environmental modification in and around the refugee camps can also have a significant longer-term impact on the local malarial ecology to the point whereby simply treating the persons infected with malaria is not sufficient to restore the region to the low endemicity that pre-existed the refugee influx. Meade and Earickson (2000) discuuss how a mere change in the housing and living patterns of inhabitants can escalate the incidence of malaria and make an area uninhabitable.

A final complication is that the high influx of refugees routine malaria prevention and control activities are interrupted by refugee crises as health professionals are mobilized to deal with emergencies. Supplies of antimalarial drugs are disrupted, as military and other expenditures rise at the expense of health spending (Kalipeni & Oppong, 1998). It is, therefore, virtually impossible to prescribe malaria control measures of general applicability to refugee camps.

Thus, refugee movements have the potential to significantly alter the geographic pattern of malaria prevalence and the ecology of the disease. We now examine the specific case of malaria incidence in Pakistan's NWFP after the Afghan refugee crisis.

Afghan refugees and malaria in the NWFP

The NWFP region

The North-West Frontier Province of Pakistan, one of Pakistan's four provinces, runs contiguous with the Afghanistan border for approximately 1100 km (Fig. 1). The capital of the province, and its major urban area is Peshawar. The province is further divided into administrative districts, and the western-most of these are tribal areas, i.e., semi-autonomous regions governed by tribal law under the supervision of the Government of Pakistan. The population of NWFP is around 17 million (12% of Pakistan's population), and includes over two million Afghan refugees that have immigrated since 1979. The population is overwhelmingly (85%) rural, engaged in farming and herding activities. The small urban population resides in the cities of Peshawar, Abbotabad, D.I. Khan, Mardan, and Maingora.

The physical geography of the NWFP makes it generally inhospitable for the malaria parasite. The region has extremely cold winters due to its location (between 32 and 37° of latitude north), and its high altitude (most of the province is covered with rugged mountains ranging from 150 to 3000 m above sea level). Given that the both the *anopheles* mosquitoes and the *plasmodium* parasites thrive in moderate to high temperatures, the NWFP is considered one of the most north-most areas worldwide where seasonal transmission of malaria occurs (Bouma, Dye & Kaay, 1996).

Niazi (1965), while examining malaria as a public health problem in Pakistan reported high mountainous region of the NWFP having very low endemicity. Kazmi (1996) found that the majority of the districts of NWFP had low or very low malariogenic potential, calculated on the basis of 34 physical, socioeconomic, and demographic variables. Except for some isolated epidemics in villages located in Swat and Kurram valleys, historical records confirm that the NWFP has never recorded a significant malaria epidemic prior to 1970. Overall, then, the NWFP was typical of an unstable malaria region, with its population susceptible to malaria epidemics. The incidence and geography of malaria, however, changed dramatically in the years following the entry of the Afghan refugees.

Afghan refugees in the NWFP

Prior to the decade of the 1970 s, the main movement across the border between Afghanistan and Pakistan

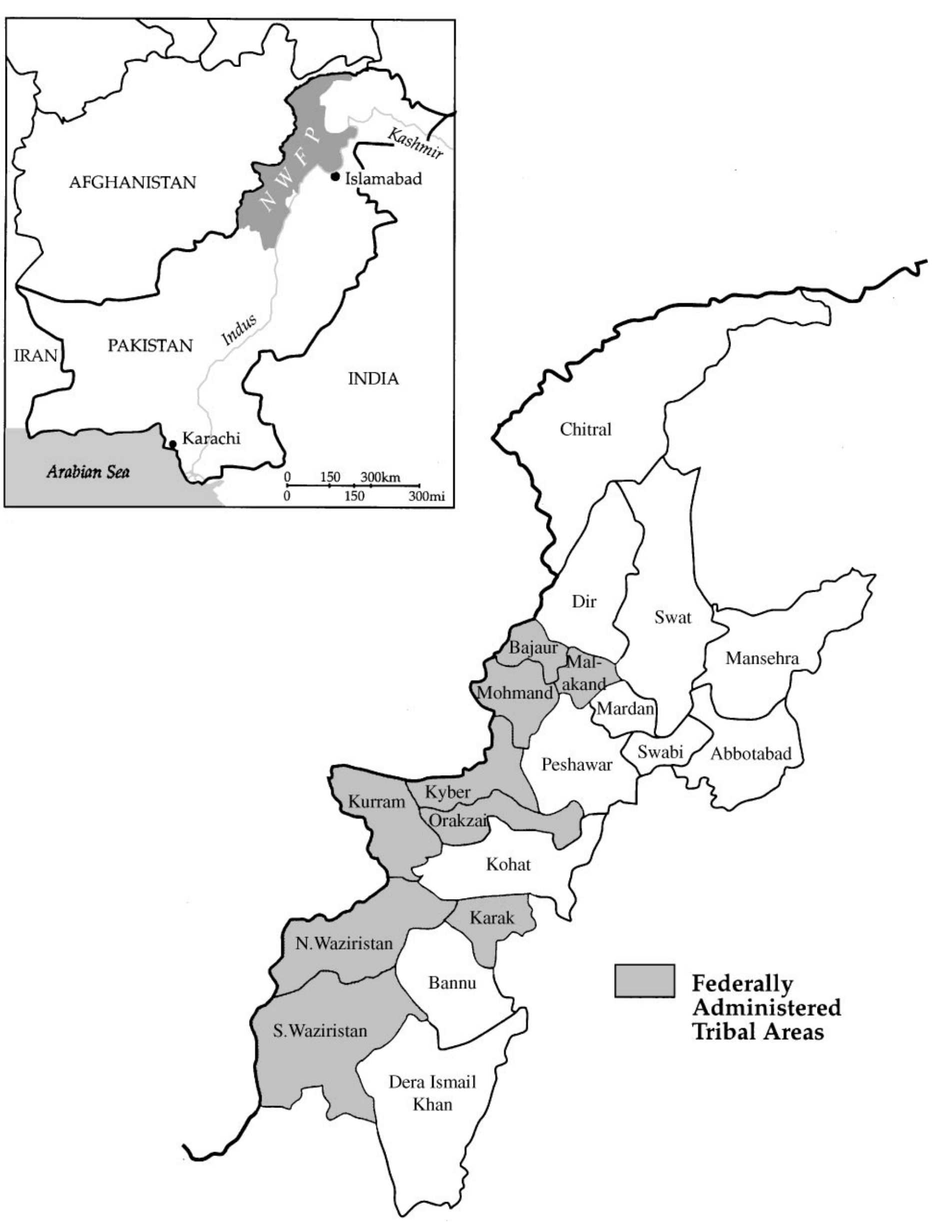

Fig. 1. Map of Pakistan showing the NWFP region.

was that of Pushtun tribes who traveled back and forth with their herds (Farr, 1985). However, beginning in 1978, Afghan refugees began arriving in Pakistan in a series of waves (Fig. 2). It is clear the throughout the time period shown in Fig. 2, the majority — 75–80% — of Afghan refugees in Pakistan is concentrated in the NWFP. The first wave of refugees, numbering almost half a million, left for Pakistan following the overthrow of the Kabul Government by the communist insurgency. The first wave was soon overshadowed by the second wave of refugees that entered Pakistan soon after the Soviet invasion of Afghanistan in December 1979. By 1981, an estimated 4700 refugees were crossing daily into Pakistan, and by 1985, there were almost three million Afghan refugees in Pakistan. The political situation worsened in the latter part of the decade as the Soviet-installed government led by Babrak Karmal' fell to Najibullah's forces. The ensuing civil war and political instability generated a third wave of refugees between 1987 and 1992 (Dupree & Dupree, 1988; Wood, 1989).

Although repatriation of Afghan refugees started in 1989 following the Soviet withdrawal from Afghanistan,

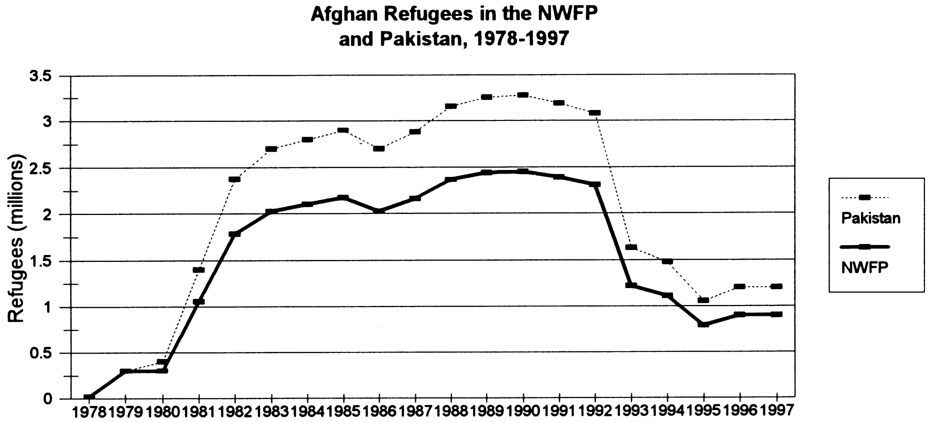

Fig. 2. Refugee flows to Pakistan and the NWFP.

Table 1
Refugees in NWFP by district, 1987[a]

District	Refugee population	Local population	Refugees per 100 local population
Abbotabad	142,642	733,643	19.44
Bajaur	195,691	264,779	73.91
Bannu	57,597	496,343	11.6
Chitral	37,385	253,415	14.75
D.I. Khan	80,129	607,783	13.18
Dir	85,039	999,288	8.51
Kohat	228,284	394,564	57.86
Kurram	347,146	304,937	113.84
Malakand	53,818	324,318	16.59
Mansehra	71,821	877,665	8.18
Mardan	103,093	1,763,357	5.85
Mohmmand	13,765	89,827	15.32
N. Waziristan	185,667	230,855	80.43
Orakzai	13,382	423,895	3.16
Peshawar	467,966	1,352,743	34.59
S. Waziristan	52,743	310,756	16.97
Swat	14,392	729,102	1.6
N.W.F.P.	2,150,460		

[a] Sources: Shahrani, 1995 and UNHCR (1997).

the numbers repatriated were far smaller than the new refugees flowing in (Wood, 1989). However, repatriations accelerated after Najibullah's fall in 1992. Since then, 2.6 million refugees from Pakistan returned to Afghanistan (UNHCR, 1998b). However, periodic outbreaks of violence in Afghanistan have resulted in renewed population displacement into Pakistan. For example, about 60,000 Afghans fled to Pakistan from September to December 1996 following the arrival of Taliban (Marsden, 1998). It is worth noting that in addition to the registered refugees shown in Fig. 2, there were about 300,000–400,000 unregistered refugees present at any given time (Shahrani, 1995; Ghalzai, 1996).

The distribution of Afghan refugees within the NWFP in 1987 is shown in Table 1. The district with highest number of refugees (almost half a million) was Peshawar. This highly urbanized district drew middle and upper income Afghans from Kabul and other cities in Afghanistan. Abbotabad, another urbanized district also drew large numbers of similar refugees. Large numbers of refugees also located along the tribal border regions of Kurrum (347,146), Bajaur (195,691), and North Waziristan (185,667). Finally, rural regions of Kohat and Mardan also received high numbers of refugees (228,284 and 103,093, respectively); the tribal areas within these districts attracted Afghan

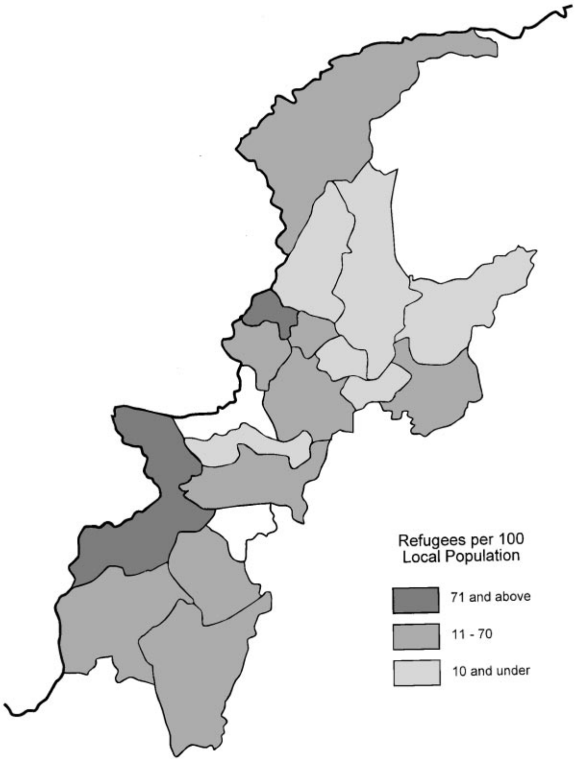

Fig. 3. Refugee concentrations in the NWFP, 1987.

refugees of ethnic backgrounds similar to the local populations.

Table 1 also gives the number of refugees per 100 local residents, a ratio that better shows the refugee impact in each district. The highest concentrations, mapped in Fig. 3 were clearly in the border regions of Kurram, Bajaur, and North Waziristan. In Kurram, for example, the number of refugees outstripped local residents: there were 114 refugees per 100 local residents. Not surprisingly, the portion of the NFWP along the Afghan border has been described as having the heaviest refugee concentrations anywhere in the world (Allan, 1987; Rogge, 1987). The high numbers and concentrations of Afghan refugees in these districts carried major implications for the incidence and spread of malaria.

Afghan refugees and malaria incidence

There is no question that malaria was a major health problem facing the large numbers of Afghan refugees in the NWFP. In the decade of the 1980 s, approximately 100,000 cases of *plasmodium vivax* and 30,000 cases of *plasmodium falciparum* were annually diagnosed and treated at NWFP clinics managed by UNHCR and voluntary agencies. Numerous studies have drawn attention to the high malaria incidence amongst Afghan refugees (Suleman, 1988; Rowland et al., 1994, 1997; Bouma et al., 1996).

To fully understand the malaria risk and incidence amongst the Afghan refugees, it is useful to comment briefly on health conditions at their point of origin. Afghanistan has long been amongst the world's poorest countries, and the basic necessities for health — clean water, sanitation, and adequate food — are in short supply (Johnson, 1998). As recently as 1998, the country reported an infant mortality rate of 150 per 1000 live births, a rate that was two and a half times the average rate for developing countries (Population Reference Bureau, 1998). The current life expectancy is 41, as compared to the average 63 for developing countries.

Afghanistan's physical environment is similar to NWFPs, viz. it has rugged mountains and a mid-latitude location. Consequently, like NWFP, Afganistan can be characterized as an unstable endemic region, i.e., a region with year-round constant, but moderate to low malaria incidence rates. Populations in unstable malaria regions typically lack the necessary immunities to the disease, and are susceptible to epidemics. The political turmoil of the 1980 s worsened the malaria situation by disrupting malaria control activities. Health expenditures were replaced by military expenditures, medical personnel were denied access to malaria-prone regions, and a severe shortage of medical workers was created as many fled for their lives. Further, the Soviets, by some accounts, systematically destroyed the ancient irrigation system, which was vital part of the Afghan agricultural economy (Skogland, 1988). In addition to causing a decline in agricultural production, this action created vast numbers of stagnant water pools and led to a sharp increase in malaria incidence. The high malaria incidence, in turn, took its toll on the agricultural labor force and production, creating malnutrition problems that, in turn, reduced the Afghan population's resistance to malaria.

The in-migration of refugees worsened the malaria situation in the NWFP in at least two ways. First, many refugees arrived in the NWFP already infected with malaria, having succumbed to the worsening malaria conditions within Afghanistan. This enormous additional caseload caused a setback to Pakistan's malaria control program (Government of Pakistan, 1989) leading to the transmission of the disease to the local population. Other refugees, their immunities lowered due to exhaustion and malnourishment, contracted malaria shortly after arriving in the NWFP (Suleman, 1988, Bouma et al., 1996). In either case, the population suffering from or at risk of contracting malaria significantly increased in the NWFP as did the malaria parasite reservoir. Further, many young male refugees continued their involvement in the political conflict in Afghanistan, leading to a higher malaria risk.

Compounding the problem were the conditions in the Afghan refugee camps. The Afghan refugees were housed in refugee tented villages (RTVs) set up by the Pakistan Government (Dupree, 1988). In 1987, there were a total of 248 RTVs in the NWFP (Table 1). Official government policy mandated that individual RTVs may not house more than 10,000 persons or 1500 families. Yet, as Table 1 shows, RTVs in four districts, Chitral, Kohat, Kurram, and Malakand, averaged refugee populations in excess of this threshold, and individual RTVs routinely contained populations in excess of 30,000.

The areas around the refugee settlements quickly became barren as trees and shrubs were cut for firewood (Azhar, 1990). Afghan refugees also brought with them more than 3 million head of livestock, which stripped the remaining vegetation through their grazing. The scarcity of vegetation around the settlements, as discussed earlier, restricted mosquito activity to the refugee camp itself, and increased the risks of being bitten by an infected mosquito.

Within the refugee camps, most families replaced their tents with permanent Afghan-style adobe structures that also housed their livestock (Shahrani, 1995; Dupree & Dupree, 1988; Bouma & Rowland, 1995). The effect of keeping cattle in the vicinity to the living quarters on malaria transmission is the subject of some debate. Hewitt, Kamal, Muhammad and Rowland (1994) among others argue that the close proximity of cattle heightens the risk of being bitten by the *anopheles* and contracting malaria. Others such as May (1958) maintain that the animals actually reduce the intensity of transmission to humans because the mosquitoes are attracted to the cattle, away from humans. Regardless, the cattle provided an abundant food supply that caused mosquito populations to thrive and multiply.

In addition to the high malaria incidence amongst the Afghan refugees themselves, the local populations living close to the regions of refugee settlement also experienced a heightened risk. While RTVs physically resembled refugee camps around the world, they were distinct in that they were not closed off from the outside world. No barriers surrounded the RTVs and refugees were permitted to move in and out freely, and indeed relocate to anywhere within Pakistan. This meant that refugees including those infected with chloroquine-resistant parasites could introduce malaria to other areas simply through routine interactions. Similar patterns of malaria transmission by mobile workers within a "labor-shed" has been demonstrated by Prothero (1961). Although the local population in the NWFP had developed a level of immunity to the disease, under prolonged periods of transmission this immunity can be lost. In the 1980s, this was the case in the NWFP where the local populations developed severe malaria as transmission from refugees steadily increased.

Combating the increasing prevalence of malaria required stepping up malaria prevention and control activities. All refugee camps were provided with basic health units or sub-health units by the Pakistan government, and several national and international agencies worked to provide health services to refugees. The basic health units, however, were typically understaffed and poorly equipped, and many Pakistani physicians and health workers refused to serve under the difficult conditions in refugee camps (Howard-Merriam, 1987; Suleman, 1988). Curiously, even the inadequate services were often underutilized. In particular, Afghan women, who comprised a large share of the refugees (Dupree, 1987), were reluctant to go to the basic health units (Martin, 1991; Farr, 1985). Challenges were also posed by the high mobility of the refugees which made it difficult to mount a concerted effort to combat and treat malaria cases.

Given all these hurdles, it is commendable that there were no widespread epidemics reported in the refugee camps (Dupree & Dupree, 1988). Indeed, Hussein (1989) concluded that the level of health services provided to Afghan refugees in Pakistan exceeded that which was available to refugees prior to displacement.

The changing geography of malaria in the NFWP

Our study, then, looks at the manner in geography of malaria in the NWFP was altered by the influx of refugees. To do this, we examine the temporal and spatial patterns of malaria incidence between the early 1970s and the early 1990s.

Data and methodology

The data used in the study were derived from the Annual Reports of Director General Health, Pakistan and from unpublished records of the Malaria Control Program (MCP). This program was initiated in 1975 in the wake of an extremely severe nationwide outbreak of malaria. It was designed in consultation with provincial Governments, The World Health Organization, and the US Agency for International Development and replaced the highly criticized Malaria Eradication Program that had been previously in place. The MCP provides spatially detailed information on malaria incidence at the scale of malaria control zones (MCZs), which largely coincide with the districts shown in Fig. 1. The MCP data are based upon blood samples collected by active case detection and passive case detection methods. In the first case, a trained malaria worker takes blood smears from persons with a fever or a history of fever by visiting each house in a subsector at regular intervals. In the latter case, blood slides from all fever cases reported to health centers or to voluntary collaborators are counted.

In both cases the number of slides exhibiting the positive presence of the malaria parasite are treated as the actual cases of clinical malaria.

We converted the MCP malaria case/count data into incidence rate data by standardizing it by the population of the zone/district as follows:

$$\text{Malaria incidence rate} = \frac{\text{Positive cases of malaria}}{\text{Population of the zone}} \times 100,000.$$

This approach of calculating the incidence rate based upon the microscopically confirmed case data is consistent with the methodology of Paul (1984), Learnonth (1988), Beaglehole, Bonita and Kjellstrom (1993), among others.

We calculated the malaria incidence rates for each year from 1972, the first year that zone-specific data began to be collected, to 1997. The only exceptions were the Federally Administered Tribal Agencies (Fig. 1), for which there is no data prior to 1985. This is because, prior to this year, the slide positivity rates for these zones was so low, that routine monitoring for malaria was not considered necessary. It was only after malaria cases began to increase sharply in the late 1980 s that these tribal zones began to be monitored on a routine basis.

Historical trends in malaria incidence

Fig. 4 plots the malaria incidence rates for Pakistan, the NWFP, and the Tribal Agencies of the NWFP over the 1972–1997 period. The 1970 s saw extremely high and unprecedented incidence rates of malaria in Pakistan, peaking at 1318 per 100,000 persons in 1975. This was due to a severe epidemic caused by floods in Punjab and Sindh provinces. Given that the NWFP borders on Punjab, incidence rates rose sharply in the region, although they were considerably lower than the national average. By 1978, malaria rates in both Pakistan and the NWFP had fallen to their pre-epidemic levels, a decline that was considered to signal the remarkable success of the newly initiated Malaria Control Program.

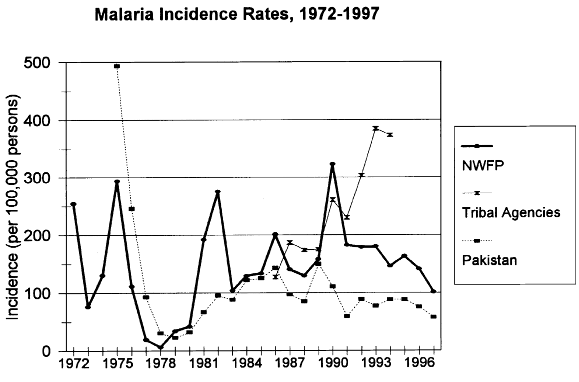

Fig. 4. Malaria incidence rates, 1972–1997.

The period following 1980 in the NWFP was characterized by a steadily increasing trend in malaria incidence, punctuated by periodic surges in incidence rates. Further, malaria incidence rates in the NFWP exceeded those for Pakistan as a whole, with the gap widening towards the end of the time period. This was in sharp departure to the pre-1980 s pattern when malaria incidence in the NWFP was consistently below the national level. The link between the rise in the NWFP malaria rates and the Afghan refugee influx is unmistakable. The first sharp increase in malaria incidence occurred in the early 1980 s, coinciding with the heavy, second-wave influx of Afghan refugees (Fig. 2). A second major epidemic in the NWFP was recorded in 1989–1990, shortly after the entry of the third wave of Afghan refugees. Worsening the situation was the growing resistance of the *anopheles* mosquito to commonly used insecticides and the increasing resistance of the malaria parasites to *chloroquine* (Shah, 1992; Shah, Rowland, Mehmood, Mujahid & Razique, 1997).

Although refugee repatriation began in 1989, malaria rates did not subside. Quite the contrary, in 1990 the NWFP experienced the highest malaria incidence in its recorded history (323 per 100,000). This fact supports our contention that the presence of Afghan refugees in the NWFP is likely to have fundamentally modified the ecology of malaria to the point where the simple repatriation of the refugees was not sufficient to restore the region to the low endemic pattern that had pre-existed. It was not until the mid-1990 s that the incidence rates began falling slowly, approaching the pre-refugee levels.

Fig. 4 also includes malaria incidence rates for the Tribal Agencies of the NWFP for the 1980 s and early 1990 s. It is clear that these regions experienced the sharpest and most sustained increases in malaria incidence rates. These regions, as shown in Fig. 1, border on Afghanistan, and were the sites of a disproportionate number of RTVs. Refugee movements, then, had triggered a shift in the geography of malaria in the NWFP, to which we now turn.

Geography of malaria in the NWFP

To examine the spatial patterns of malaria incidence, we first converted the annual malaria incidence rates for each district into their standardized values as follows:

$$SM_{it} = (M_{it} - M_t)/SD_t,$$

where SM_{it} is the standardized malaria incidence rate for district i in year t, M_{it} is the actual malaria incidence rate for district i in year t, M_t is the average malaria incidence rate for all districts in year t, and SD_t is the standard deviation in the malaria incidence rate in year t.

The. standardized values are therefore simply the z-scores of the actual distribution. The advantage of calculating and mapping z-scores instead of the actual values is that they allow the *relative* spatial dispersion of malaria rates to be emphasized over the temporal fluctuations. Thus, our interest here is to see which NFWP districts, relatively speaking, have higher or lower than average malaria incidence regardless of whether the average itself was high or low.

Figs. 5–7 map the standardized malaria incidence rates for the NWFP annually for, respectively, 1972–1980 (low refugee presence in NWFP), 1982–1990 (high refugee presence), and 1990–1997 (shift from high to low refugee presence).

Between 1972 and 1980 (Fig. 5), the above-average incidence of malaria in the NWFP was in the south-eastern portion, specifically Kohat, Bannu, and D.I. Khan. This period coincided with epidemic malaria throughout Pakistan, and these three NWFP districts all shared a border with Punjab, where the epidemic was particularly widespread. Malaria in the northern portions of NWFP was below the average for the entire time period. The only exception was Swat, which showed an incidence rate well above average in 1978–1979. However, it is worth noting that the overall incidence rate in these years was extremely low (Fig. 4), and even a well-above average incidence does not imply a significant malaria problem.

By 1980, as noted earlier, malaria incidence was on the rise in the NWFP. The turn of the decade also marked the beginning of the Afghan refugee influx and, for the first time, NWFP's incidence rates began to exceed those for the country as a whole. Fig. 6 presents the geography of malaria over the 1982–1990 period and clearly provides evidence of a shifting spatial pattern of the disease. The highest rates of malaria incidence now began to be reported in the northern and western portions of the NWFP. By the end of the decade, there emerged an axis of relatively high malaria incidence stretching from Chitral and Swat in the north, through Swabi, Mardan, Malakand, to Mohmmand and Khyber along the western boundary with Afghanistan. The malaria axis included two types of provinces: those having a high concentration of refugees (Chitral and Malakand, for example, had over 12,000 refugees per RTV), and those that had a well-developed road networks linking them to the refugee concentrations.

Besides the north and west, there was also a continuation of relatively high malaria rates in the

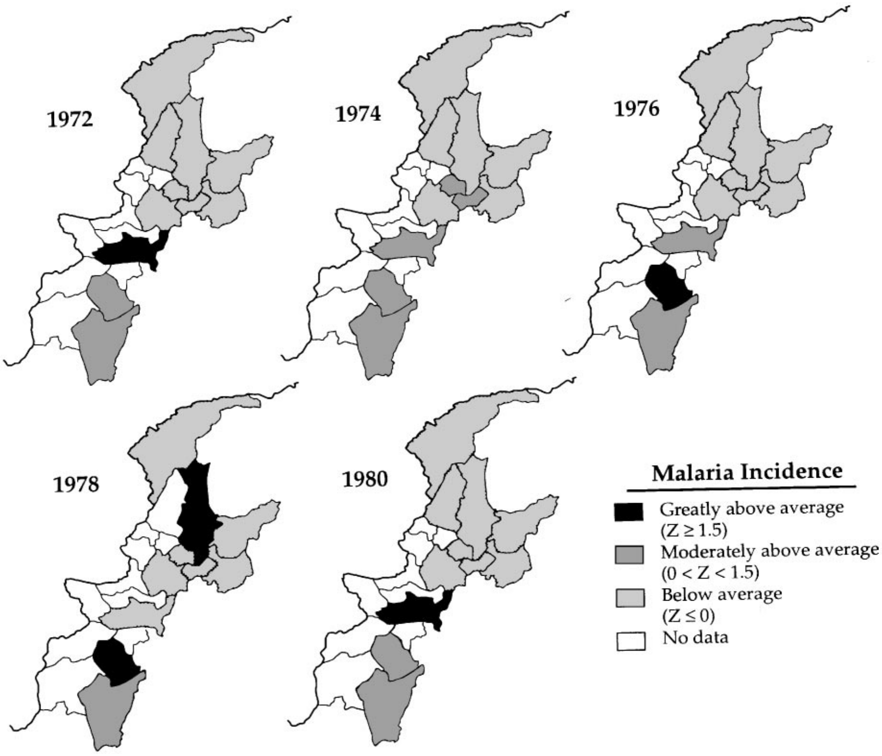

Fig. 5. Malaria incidence in the NWFP, 1972–1980.

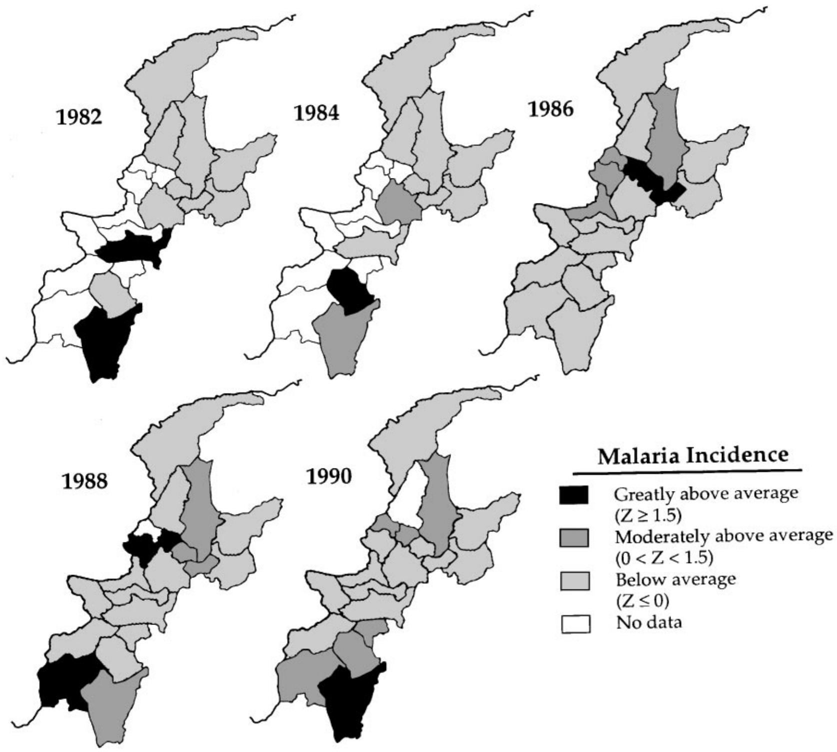

Fig. 6. Malaria incidence in the NWFP, 1981–1989.

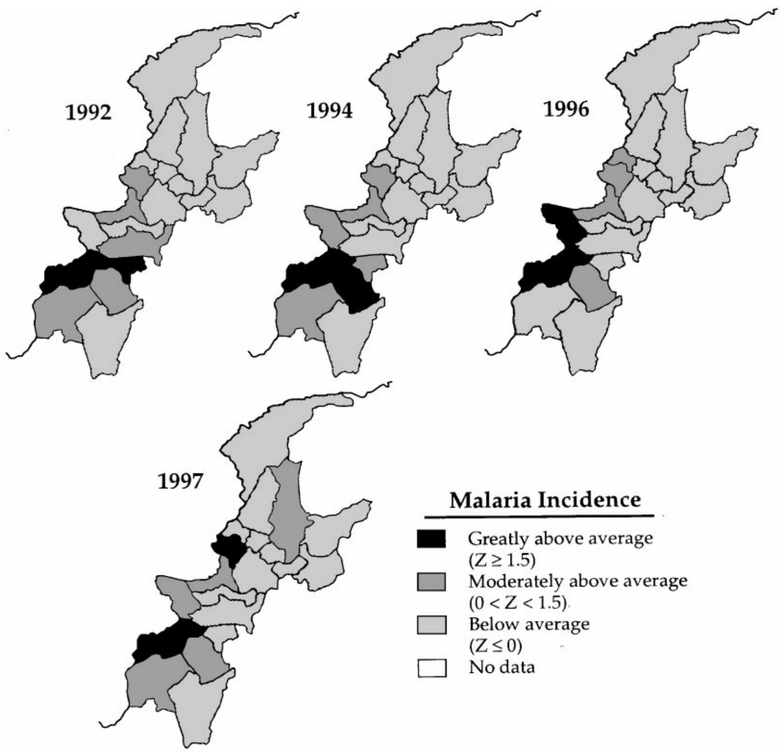

Fig. 7. Malaria incidence in the NWFP, 1990–1997.

south. Kohat, Bannu, and D.I. Khan continued to report above average incidence for most of these years — not coincidentally, all three were important sites of refugee resettlement. Further, as data on the tribal agencies began to be reported, South Waziristan, located in the southwestern corner of NWFP, was added to the map of above average malaria incidence as a consequence of high refugee influx coupled with poor health infrastructure.

In the years following 1990 (Fig. 7), the geography of malaria shifted once again. From the two separate clusters of high malaria incidence in the North and South, a single consolidated band of high malaria incidence emerged along the central-to-south part of the western border, i.e., stretching from Mohmmand to South Waziristan. This change reflected an important shift in the geography of the refugees who had begun to be repatriated in large numbers from the established RTVs. By 1997, the overall malaria incidence rates in the NWFP had declined close to the 1972 levels. Yet, the comparison of the disease maps for 1972 (in Fig. 5) and 1997 (in Fig. 7) shows that the geography of malaria in the NWFP has been fundamentally altered: the border districts that had previously experienced low endemicity had begun reporting the highest malaria incidence in the NWFP. The changes wrought by the refugee presence — deforestation and vegetation removal, creation of excavation sites that had become breeding pools for mosquitoes, etc.—then, had left a long lasting impact on the ecology of malaria Table 2.

Conclusions

Our paper examined these links between refugee inflows and the geography of malaria in Pakistan's NWFP province, which received a staggering two and a half million Afghan refugees in the 1980 s. These refugees were settled mainly in the western tribal districts along the border and in the larger inland districts. An immediate consequence of the entry of the refugee populations in these districts was the rise in the parasite reservoir — a high share of the refugees either arrived already infected with the disease or contracted it shortly after arrival due to a decline in their disease resistance brought on by malnourishment and exhaustion. Conditions in the refugee camps also contributed to the high incidence and spread of malaria. Camps were typically overcrowded and unsanitary. This, together with the practice of refugees of keeping their animals in close proximity to living quarters, created a fertile breeding ground for the *anopheles* vector. Finally, the freedom of movement given to Afghan refugee camps meant that conditions within refugee camps could be easily exported to neighboring areas.

In the light of this background, we were not surprised to find that there was a significant change in the geography of malaria over the time period examined. In the early 1970s, the districts with the highest incidence of malaria occurrence were located in the southeast, along the border with Punjab province. The frequent floods in Punjab and the humid conditions there made it particularly hospitable to the *anopheles* vector. Over the

Table 2
Number and average size of refugee tented villages (RTVs) by district, 1987[a]

District	Refugee population	Number of RTVs	Refugees per RTV
Abbotabad	142,642	18	7925
Bajaur	195,691	25	7828
Bannu	57,597	6	9600
Chitral	37,385	3	12,462
D.I. Khan	80,129	10	8013
Dir	85,039	9	9449
Kohat	228,284	18	12,682
Kurram	347,146	33	10,520
Malakand	53,818	3	17,939
Mansehra	71,821	9	7980
Mardan	103,093	17	6064
Mohmmand	13,765	2	6883
N. Waziristan	185,667	24	7736
Orakzai	13,382	2	6691
Peshawar	467,966	61	7672
S. Waziristan	52,743	6	8791
Swat	14,392	2	7196
N.W.F.P.	2,150,460	248	8671

[a] Source: Shahrani, 1995 and UNHCR (1997).

1980s, however, the highest malaria incidence gradually began to be found in the west, along the Afghan border, and in the northern provinces that also housed disproportionate numbers of refugees. Prior to the 1980 s, these districts had experienced heightened malaria incidence only sporadically since their cooler and drier environments were not ideal for the parasite or the vector. Most notable, however, was the observation that the new geography of malaria persisted into the 1990 s, well after the repatriation of Afghan refugees had begun. The environmental modifications resulting from refugee occupation, e.g. vegetation removal, excavation of pits, etc., had fundamentally changed the disease system in the NWFP.

The examination of how population movements influence the geography of health is vital in an environment of accelerated international migration and large-scale refugee flows. The success and efficiency of health care delivery systems will increasingly depend on our ability to understand how these flows will affect not only the prevailing spatial patterns of a disease, but its ecology as well. We hope that our study stimulates further work in this timely and exciting area of research.

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