Introduction

From 10 to 17 June 2013, a team from Medical Checks for Children (MCC) checked and treated 840 children, aged 13 years and below, free of cost. This mission was the third MCC mission to the Ladakh Region, which was visited by MCC for the first time in July 2011. The mission was organized on invitation by and in collaboration with the following local partners: Ad van Beckhoven (representing the local non-governmental organization PranaPlanet), Tashi Palzom (Riglam School, Leh), and Dr Nordan Otzer (Himalaya Health Project, Nubra valley). Official approval for the mission was requested and obtained from the Ladakh Autonomous Hill Development Council. The mission's objective was to assess the general health status of children in the region; provide basic health care, free of cost; and raise awareness of health, hygiene, and nutrition. The mission was made up of two parts. From 10 to 12 June, the MCC team worked in the Nubra valley (first visited in 2012). From 14 to 17 June, the team worked in the Indus valley (first visited in 2011).

The MCC team consisted of ten members from The Netherlands. Medical doctors on the team were Cora Stronkhorst (general physician), Jana Wissekerke (general physician), Annemarie Winkelhagen (biologist, general physician in training), Ans van Breukelen-Avezaat (retired youth doctor), and Luc Coffeng (MD, epidemiologist). The team was completed by Stephen van den Elshout (IT specialist), Liesbeth Hunsche (human resources manager), Judith Siereveld (executive secretary), and Hans van Loon (family coach). The team was coordinated and led by Hans van Loon (logistic mission leader) en Luc Coffeng (medical mission leader). Technical equipment for the health checks was brought from The Netherlands by MCC team members. Medication was ordered from and delivered by Dawa Sonam, Dumra Agencies (Pharmaceutical and Surgical Distributors) in Leh, Ladakh.

This report summarizes the medical findings of MCC's mission in the Ladakh and aims to provide a set of recommendations and action points for improving the health of children in the Ladakh region, following up on earlier sets of recommendations that were provided in the reports on the previous missions (July 2011, June 2012). Furthermore, we report on the follow-up of height, weight, and haemoglobin levels of children who have been checked by MCC for at least two times.

Mission procedure

The medical checks were performed at six locations, where children of several schools and areas were examined (Table 1). Prior to the start of the mission, local partners discussed suitable dates for the mission at schools in the area, and asked that children be presented in presence of their guardians. Also during the mission, local partners and volunteers again went to the candidate schools and communities, asking local leaders to present the communities' youngest (age zero to five) and sick children first, in presence of their guardians. During the mission, children came to the mission location by foot or were picked up by a school bus and brought there.

Table 1: Overview of number of children checked by school or place of stay, date, and location of checks.

Date of checks	Location of checks (approximate altitude)	School or place of stay of checked children	Number of children examined (number of children seen for second or third time)
10 June 2013	Lamdon School Diskit (3000m)	Lamdon School Diskit	182 (144)
		Model School Diskit	28 (0)
11 June 2013	Turtuk, local school yard (2500m)	Turtuk	108 (0)
12 June 2013	Lamdon School Sumoor (3000m)	Lamdon School Sumoor	163 (0)
		Government School Sumoor	17 (0)
14 June 2013	Alchi Institute (3500m)	Alchi Institute	69 (38)
15 June 2013	Tibetan Refugee Camp #4 (3500m)	Riglam School	64 (36)
		BVN School	42 (16)
		Police Public School	36 (0)
17 June 2013	Druk White Lotus School (3500m)	Druk White Lotus School	131 (79)
10–17 June 2013		Total	840 (313)

Despite precarious forward planning in collaboration with local partners and schools, three schools declined to participate in the scheduled medical camps at the last minute for unclear reasons: one school declined on the day of camp itself, and another school declined one day in advance. As a result, the MCC team was forced to cancel one and a half day (out of six days) of planned work. Fortunately, this loss was partly compensated for by extending the mission by one day until Monday 17 June and visiting the Druk White Lotus School in Sheh.

During the mission, the check-up procedure of children was as follows. When children arrived at the medical camp, they were given a numbered case report form and their name, age and a preliminary medical history were written on the form by local volunteers. If the child was known to have been previously checked by MCC (in 2011 or 2012, as confirmed either by child, teacher, or guardian), the previous case report form was looked up and stapled to the new form. A unique MCC-number was allocated to each child (linked to a previous year's number, if applicable) to make future follow-up possible. The case report form was then given to the child who kept it until his or her medical check-up was completed.

At the next station, children were weighed and their height was measured using a tape measure attached to the wall. Height and weight were compared to international standard growth curves (World Health Organization) to determine whether children were lagging behind in their growth.

Next, children's haemoglobin (Hb) levels were assessed by means of spectrography (Hemocue), using finger prick blood. Anaemia (low Hb) was determined based on criteria by the Center for Disease Control (CDC)[1]. These criteria were developed for individuals residing at (approximately) sea-level. Because in Ladakh, children reside at high altitude, Hb levels should be higher than in children at sea-level. Therefore, we adjusted the CDC criteria for long-term exposure to high altitude (Appendix A: Criteria for anaemia). With this adjustment, anaemia was almost equally prevalent in all age categories during previous MCC missions to Ladakh (2011, 2012), whereas normally, in developing areas, anaemia is more prevalent in younger children. We therefore re-examined the haemoglobin data from previous missions, and concluded that if a weaker adjustment for altitude is handled, the expected age-pattern in anaemia is actually there. In other words, the criteria for anaemia may have been too strict during previous mission. Therefore, during the 2013 mission, we used a weaker adjustment for altitude; we based criteria for anaemia on the lower altitudes (e.g. ~2000m instead of ~3500m for children from Leh). This is also more in agreement with local medical standards for assessing anaemia (minimum Hb 110 gr/l for children and Hb 130 gr/l for adults).

After assessment of Hb levels, each child was physically examined by one of the medical doctors. Doctors prescribed treatment when needed (in most cases for anaemia, vitamin deficiency, or prophylactic anti-worm treatment). Medication was dispensed on site (if necessary and available) upon turning in the case report form.

Next, children (and their guardians) were gathered into groups of fifteen to receive interactive health education by a MCC team member and a local volunteer. Children (and their guardians) were asked about their usual health-related behaviour (hand washing, tooth brushing, and dietary habits). Then, health education was given on each subject, adapted to the knowledge and habits of the persons receiving it. After reviewing the respective parts of the health education, every child got a toothbrush, toothpaste, and a bar of soap.

In case of dental problems, children were referred for dental check-up at the army dental camp in Nubra Valley or the dental surgery department at the government hospital in Leh. All data were digitally registered on location. In case of need for further diagnosis, follow-up (e.g. Hb < 5.5 mmol/l), or treatment, children were referred to the nearest hospital.

As during previous medical missions, we made efforts to include local volunteers (medical workers, teachers, students etc.) in helping with translation during the check-up and taking care of the children.

[1] *CDC criteria for anaemia in children and childbearing age women.* MMWR, 1989, 38:400-404.

Diagnoses and treatments

A total of 840 children were checked during the mission (Table 2). Due to the high risk of mortality and morbidity under five years of age in developing areas, the focus of MCC is checking young children. Off all checked children, 99% of the children were twelve years or younger (68% in 2011, 85% in 2012), and 25% of the children were below five years of age (7% in 2011, 20% in 2012). The majority of the cases that received our attention were anaemia and growth retardation. Most ailments could be treated on the spot. However, a number of children were referred to the nearest hospital for further diagnoses, follow-up and/or treatment. Below we will describe these matters in detail. It should be noted that differences between this mission's overall findings and that of last year are most likely due to the fact that this year, the checked children were somewhat younger on average than last year (as was the case for the difference in findings of the years 2011 and 2012).

Table 2: Number of checked children per age category, gender, and school(s) or area

	Lamdon School Diskit	Model School Diskit	Turtuk	Lamdon School Sumoor	Govt. School Sumoor	Alchi Inst.	Riglam School	BVN School	Police Public School	Druk White Lotus	Total	
Total	182	28	108	163	17	69	64	42	36	131	840	100%
Age												
<1	0	0	17	0	0	0	0	0	0	0	17	*2%*
1 – <5	4	14	78	12	2	19	14	24	11	12	190	*23%*
5 – <7	60	8	13	80	9	25	15	17	9	87	323	*38%*
7 – <9	76	1	0	60	4	21	23	1	15	29	230	*27%*
9 – <12	41	5	0	7	2	4	12	0	1	3	72	*9%*
12 – <18	1	0	0	4	0	0	0	0	0	0	5	<1%
Boy	97	8	52	77	7	36	33	21	20	75	426	51%
Girl	81	18	56	86	10	30	31	21	16	56	405	48%
Unknown	4	2	0	0	0	3	0	0	0	0	9	1%

Growth retardation (2013)

We assessed the growth status of each child by measuring his/her height and weight. Growth retardation was suspected when the measurements were very different from expected height and weight, given a child's age and gender. In developing areas, growth retardation is most often a sign of insufficient nutrition. Therefore, all cases of growth retardation were regarded as cases of malnutrition, unless there were signs for other possible explanations (e.g., tuberculosis, thyroid dysfunction, or heart murmurs). Growth retardation was assessed in three ways: 1) comparing height to expected height, given a child's age (possible up to the age of 18); 2) comparing weight to expected weight, given a child's age (possible up to age 10); 3) comparing the weight to expected weight, given a child's height (possible up to height of 120 cm). Growth retardation was diagnosed when a child's height and weight were among the bottom 3% lowest expected values (at or under the third percentile; meaning that about 97% of all healthy children in the world are probably taller and heavier).

Table 3 summarizes the findings on growth retardation. Overall, 21% of the checked children were not tall enough for their age (stunting). This problem was especially prevalent in poorer populations, such as Turtuk (47%) and children of the government school in Sumoor (53%). Children that were too short for their age were two times more likely to have anaemia than their peers. In the children up to the age of ten, 12% was not heavy enough for his/her age. Of the children up to height of 120 cm, 3.3% was not heavy enough for their length, indicating that they had recently lost weight.

As we observed very few signs of chronic illness in children and very few infections, we assume that chronic insufficient nutrition is the main cause for the aforementioned growth retardations. From our interactive health education sessions, we learned that many children are breast-fed up to two years, which is very good. However, many children start eating vegetables regularly very late in life (from 4 to 5 years onwards). Until then, most children are primarily fed staple foods such as rice and wheat porridge (tsampa), and only sporadically vegetables and fruits. As a result, many older children are not used to eating vegetables and do not like them. On top of that, (especially wealthier) parents of children between 4 to 8 years of age often reported that their children only liked cookies and sweets. However, these parents also admitted that they themselves were the ones providing their children with such unhealthy foods. These findings explain our previous observation of higher rates of growth retardation among older children (who eat little vegetables), and somewhat lower (but still high!) rates among young children (who are breast-fed or have been breast-fed until relatively recently). We therefore specifically recommend that mothers keep breast-feeding their infants for one and a half up to two years, but that they also start giving their babies vegetables and fruits (mashed) from six months onwards. This approach is not only directly healthy for the baby, but will also help the child to later appreciate and eat vegetables and fruits. For those mothers in rural areas who have to work in the fields and who can only manage two breast-feeding sessions per day (as is the case for many women in Turtuk), we recommend that between breast-feeding sessions, they provide their babies with cow-milk, which has been diluted (two parts fresh cow-milk, one part water), boiled, and let cool down.

Other remedies for growth retardation are to treat and prevent intestinal worm infection (hand washing), especially in children under five; low intake of sugary, fatty, or refined foods (e.g. Maggi); and to educate children, teachers, and parents about all the above. All growth-retarded children were given multivitamins for three months.

Table 3: Growth retardation per school/area.

	Lamdon School Diskit	Model School Diskit	Turtuk	Lamdon School Sumoor	Govt. School Sumoor	Alchi Inst.	Riglam School	BVN School	Police Public School	Druk White Lotus	Total 2013 (n / N and %)	
Height for age ≤ P3	10.4%	21.4%	47.2%	11.5%	52.9%	11.6%	26.6%	14.3%	16.7%	22.1%	166 / 806	21%
Weight for age ≤ P3	9.8%	10.7%	17.6%	8.9%	41.2%	13.0%	20.3%	4.8%	2.8%	10.0%	96 / 804	12%
Weight for height ≤ P3	2.8%	8.3%	3.7%	6.1%	7.1%	1.9%	0.0%	0.0%	3.2%	2.4%	23 / 678	3.3%

Height for age was evaluated in all children; weight for age was evaluated in children up to the age of 10 years; weight for height was evaluated in children up to a height of 120 cm.

Growth retardation (2011–2013)

Between 2011 and 2013, MCC checked a total of 2065 children, 1701 of whom were checked once, 339 twice, and 25 thrice. Figure 1 illustrates the measured height and weight in 2065 children by year, linking repeated measurements in individual children. Figures 2 and 3 illustrate the measured height and weight by age, with reference lines for the average (solid line) and minimum international growth curves (dashed line). Children who fall under the dashed line are smaller/lighter than 97% of the children in the world.

In general, the Ladakhi children than visited the MCC medical camps between 2011 and 2013 were shorter and lighter than the global average for child height and weight (Figure 3). As discussed above, this is most likely due to insufficient nutrition, although genetics and the high altitude may also play a role. Given their height, the Ladakhi children that visited our camps were not too light, indicating that acute severe malnutrition is rare.

After the mission of June 2012, MCC left a surplus supply of vitamin supplements (vitamins B1, B6, and B12) at the Lamdon School in Diskit. In agreement with school management, the hostel scholars of this school received these supplements over winter (when there are fewer vegetables). This year, we found that on average, the hostel scholars had gained one kilogram of extra weight compared to the day scholars of the same school (Figure 5), suggesting a beneficial effect of the vitamin supplement and that some children may get insufficient vitamins in winter (in this case the hostel children).

Figure 1: Follow-up of height and weight in children from 2011 to 2013. Open circles represent individual children; lines connect repeated measurements in the individual children over the years. The average height and weight of checked children declines over the years because we checked younger and younger children. In most children that were checked for more than two times, height and weight increased. Decreases in height are the result of measurement error, indicating a need for more precise measurement of height.

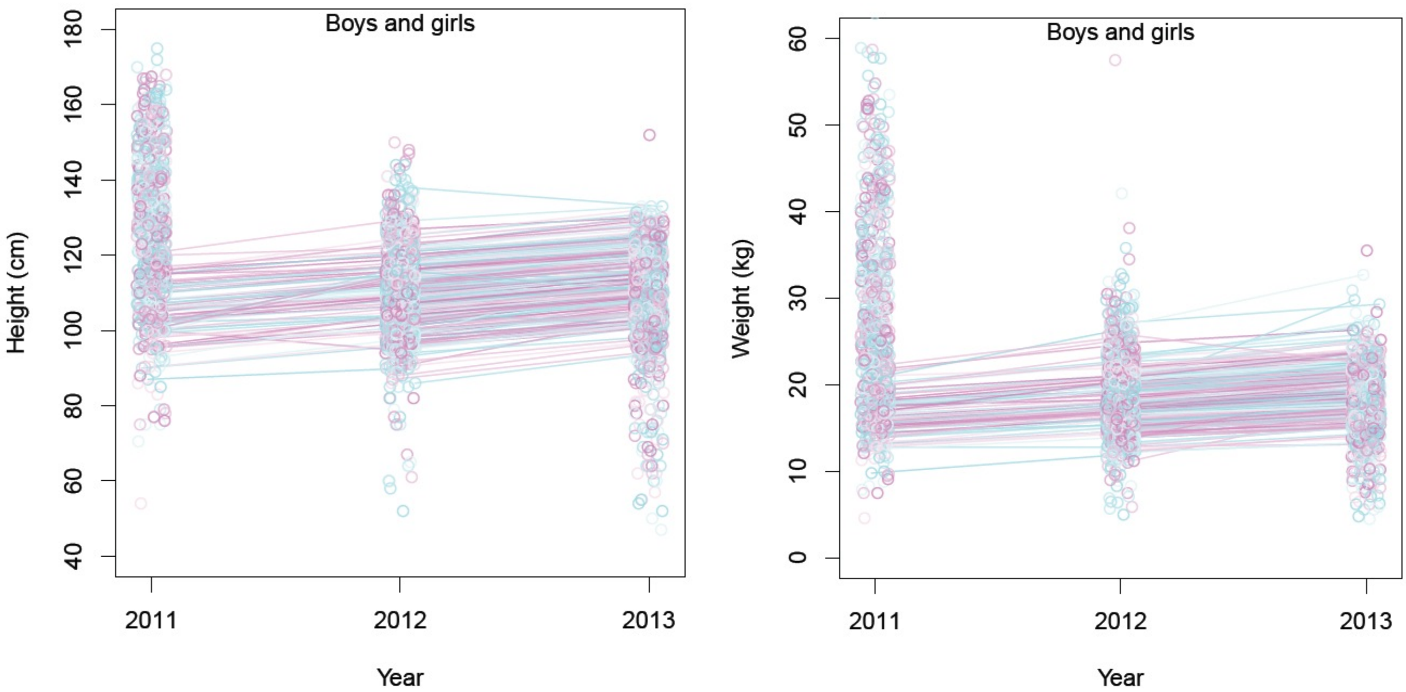


Figure 2: Height and weight by age in children checked between 2011 and 2013. Open circles represent individual children; lines connect repeated measurements in the individual children over the years.

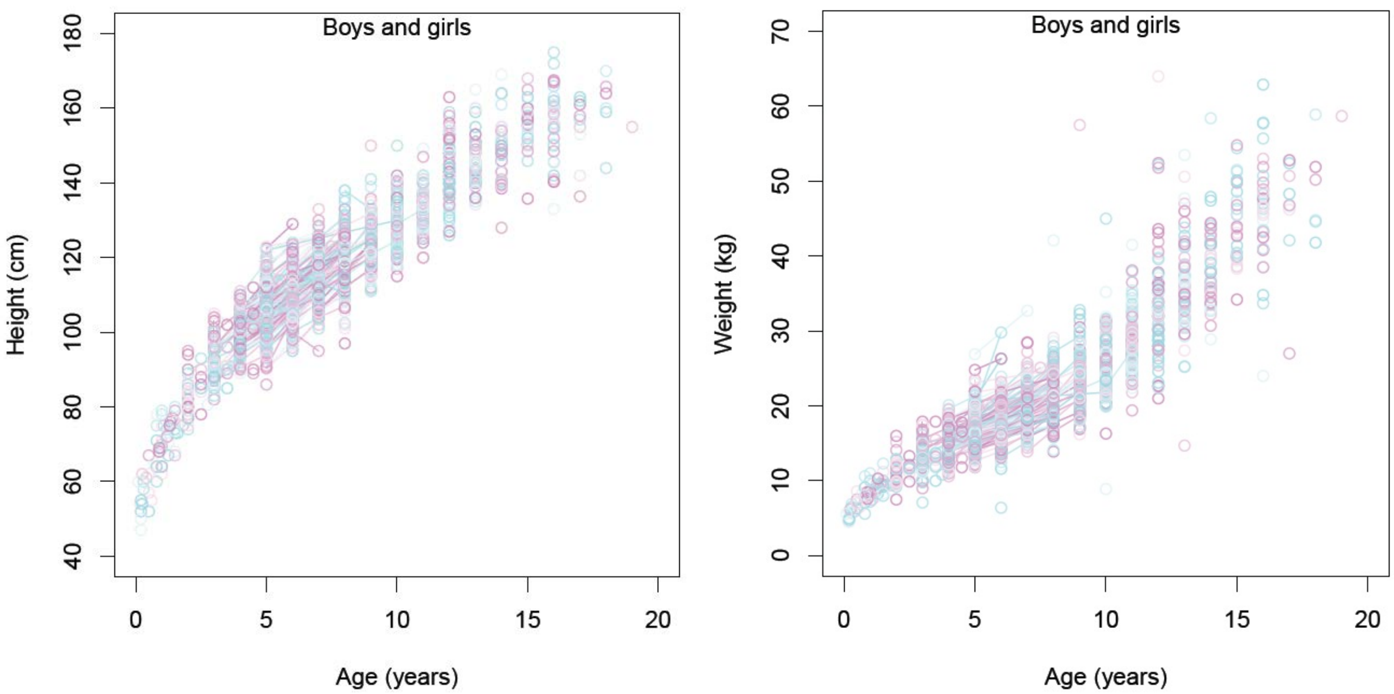


Figure 3: Height and weight by age and gender in children checked between 2011 and 2013 versus international standard growth curves. Open circles represent individual children. Average (50th percentile) and minimum (3rd percentile) height and weight for age are indicated by the solid and dashed black lines, respectively. Panels on the left illustrate height and weight data for boys, panels on the right are for girls.

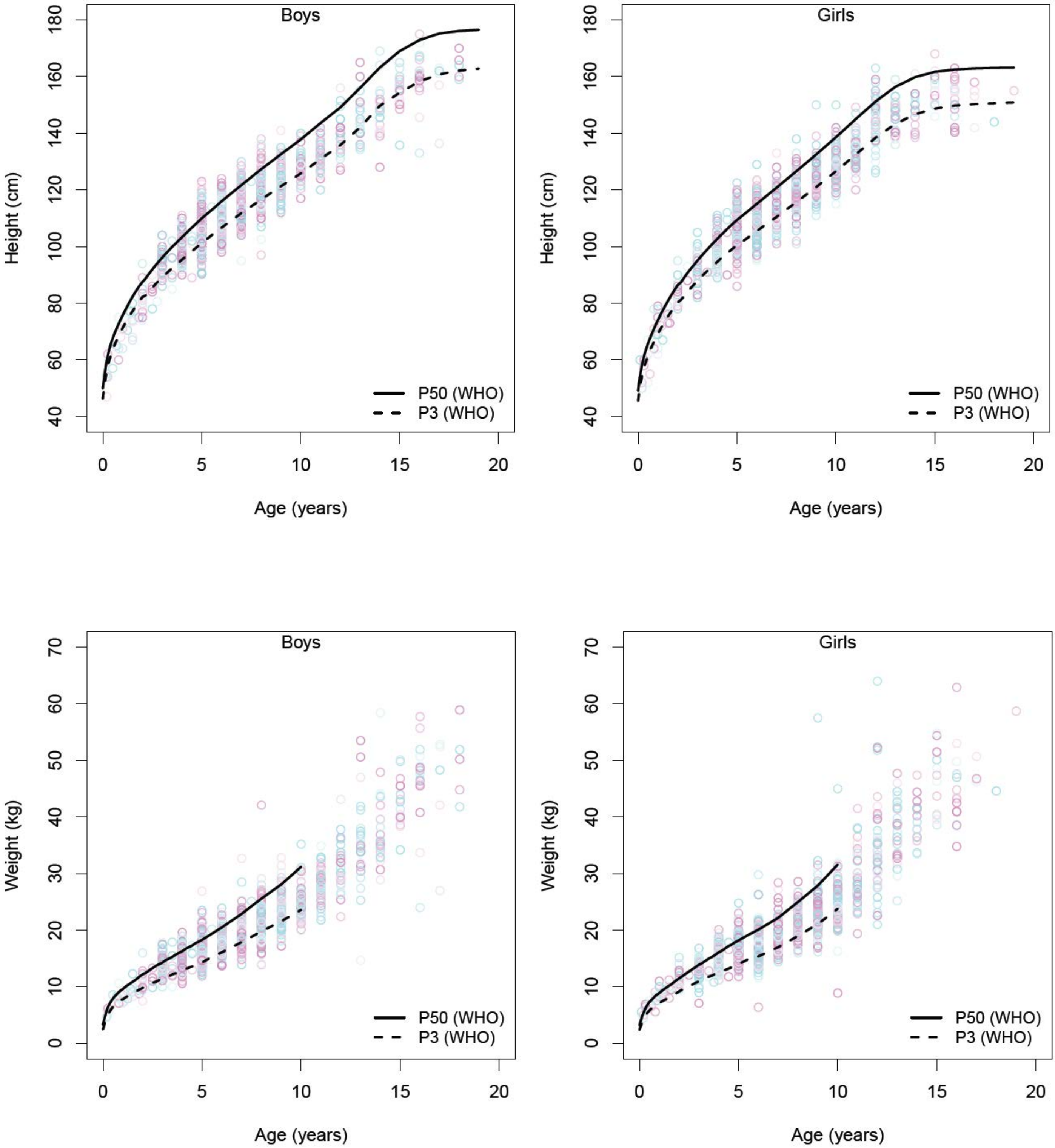


Figure 4: Weight by height and gender in children checked between 2011 and 2013 versus international standard growth curves. Open circles represent individual children. Average (50th percentile) and minimum (3rd percentile) weights for height are indicated by the solid and dashed black lines, respectively.

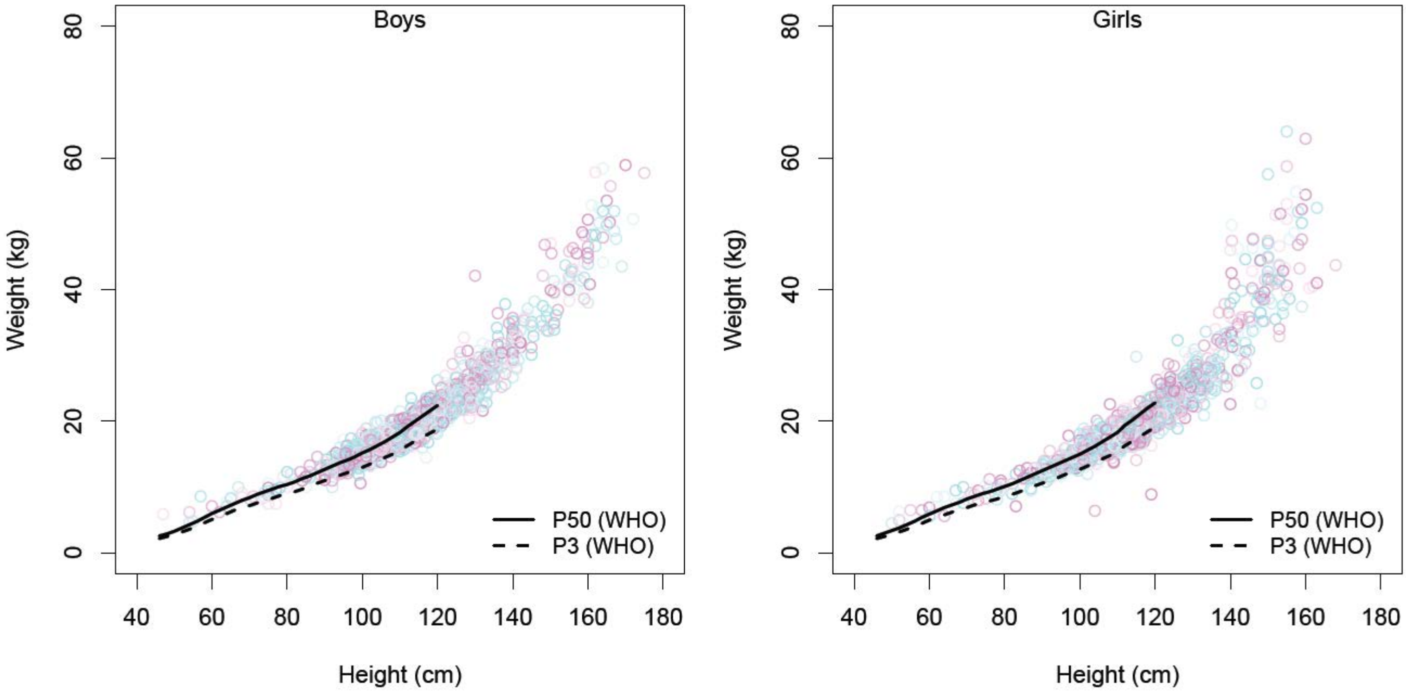
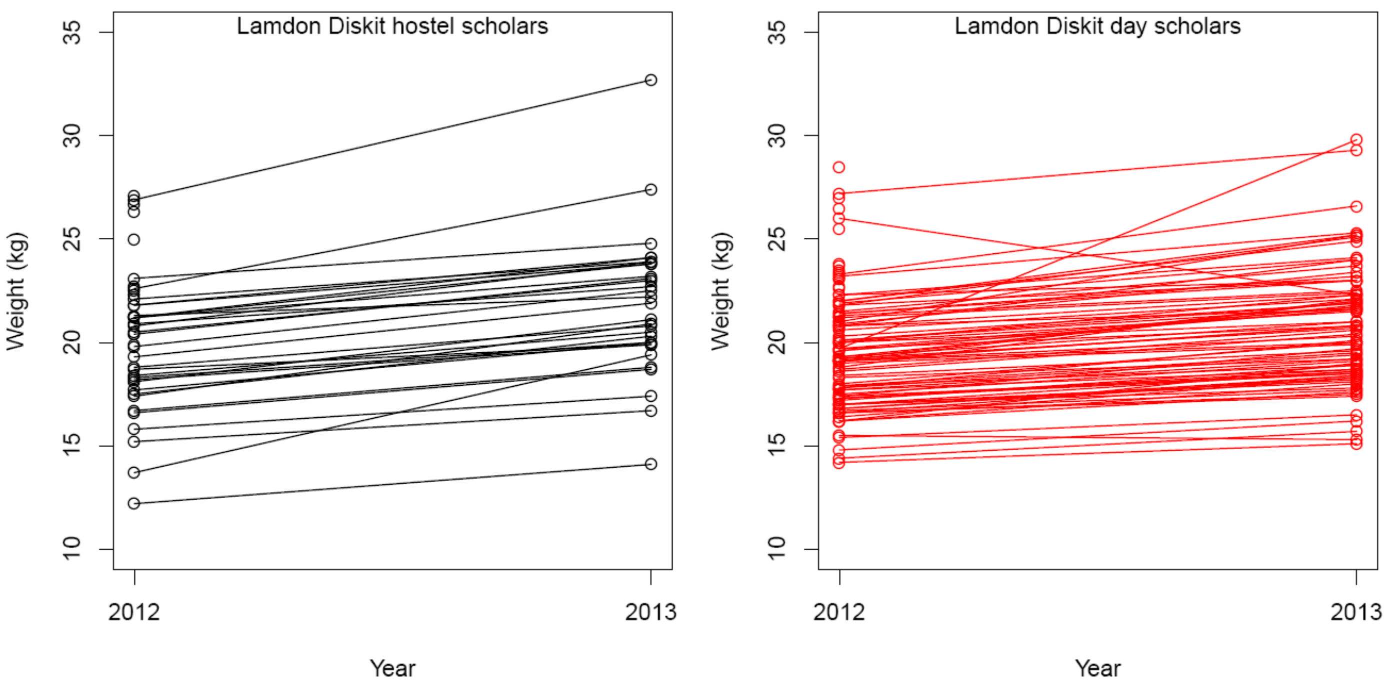


Figure 5: Weight of hostel and day scholars of the Lamdon School in Diskit, Nubra Vallay in 2012 and 2013. In the winter of 2012, the hostel scholars of this school received vitamin supplements (vitamins B1, B6, and B12) which were left over from the MCC 2012 mission. In 2013, the weight of hostel scholars had increased by one kilogram more than the weight of day scholars (p-value 0.017; corrected for age, gender, and treatment at the time of the medical camp in June 2012), suggesting a beneficial effect of the vitamin supplements.



While putting together the data from different years, we learned that reported ages of children were sometimes inconsistent over the years (e.g. same age in two consecutive years, increases in age over one year), which led to doubt the accuracy of all age data. School children's ages were either self-reported or based on what the parents/guardian had told the school at the initial school registration. Self-reporting is known to be unreliable, especially for younger children. But even birth-dates reported to the school by parents were sometimes unlikely to be true (e.g. a second grade scholar of age five, whereas his/her peers are seven to nine). Accurate information on a child's age is very important for assessing whether it is growing well. Some schools have already adopted identity cards for children, which helps prevent the inaccuracy due to ages self-reported by children. We therefore urge all schools to register the ages of children, and bring such a register (or identity cards) with them to a medical camp.

Further, while putting the height data together, we learned that there is significant error in the measurement of height of children. Some children don't grow over the year or even shrink, according to the measurements. Therefore, this year, we put extra emphasis on accurately measuring height. However, because the current measurement method (tape measure against wall) involves a interpretation by a human (i.e. putting something straight like a book on a child head, perpendicular to the wall, and then reading the tape measure), it is very sensitive to human error. Moreover, installation of the tape measure to the wall is subject to error. Altogether, this error may lead to both overestimation and more often, underestimation of height (adults are taller than children and therefore tend to hold the book – or other straight object on the head of the child – declining away from them). Therefore, we propose to use a more standardized, less error-prone method to measure height in the future. However, we do not expect that the aforementioned measurement error can explain the relatively short stature of Ladakhi children; nutrition, hygiene, and relatively low oxygen levels are most likely the most important factors for the height of Ladakhi children.

Anaemia

Anaemia (low level of haemoglobin, or Hb) is the most prevalent micronutrient disorder in developing areas. The most important causes of anaemia are malnutrition and worm infection, and more rarely chronic infectious diseases such as tuberculosis and HIV. Anaemia causes fatigue, reduced ability to concentrate and learn in school, and consequent delay in a child's cognitive development. Therefore, anaemia has significant effect of the future of a child. In India, no national policy has been implemented to provide iron supplements to pregnant women or young children. Furthermore, even though there are worm-treatment programs in India, none of the children that we checked reported receiving regular anti-worm treatment (except for hostel children of the Druk White Lotus School).

Table 4: Prevalence of anaemia among children from whom successful blood samples were obtained. Figures in parentheses are based on stricter the criteria for anaemia that were used last year (i.e. using the actual altitudes rather than the altitudes listed in the first column).

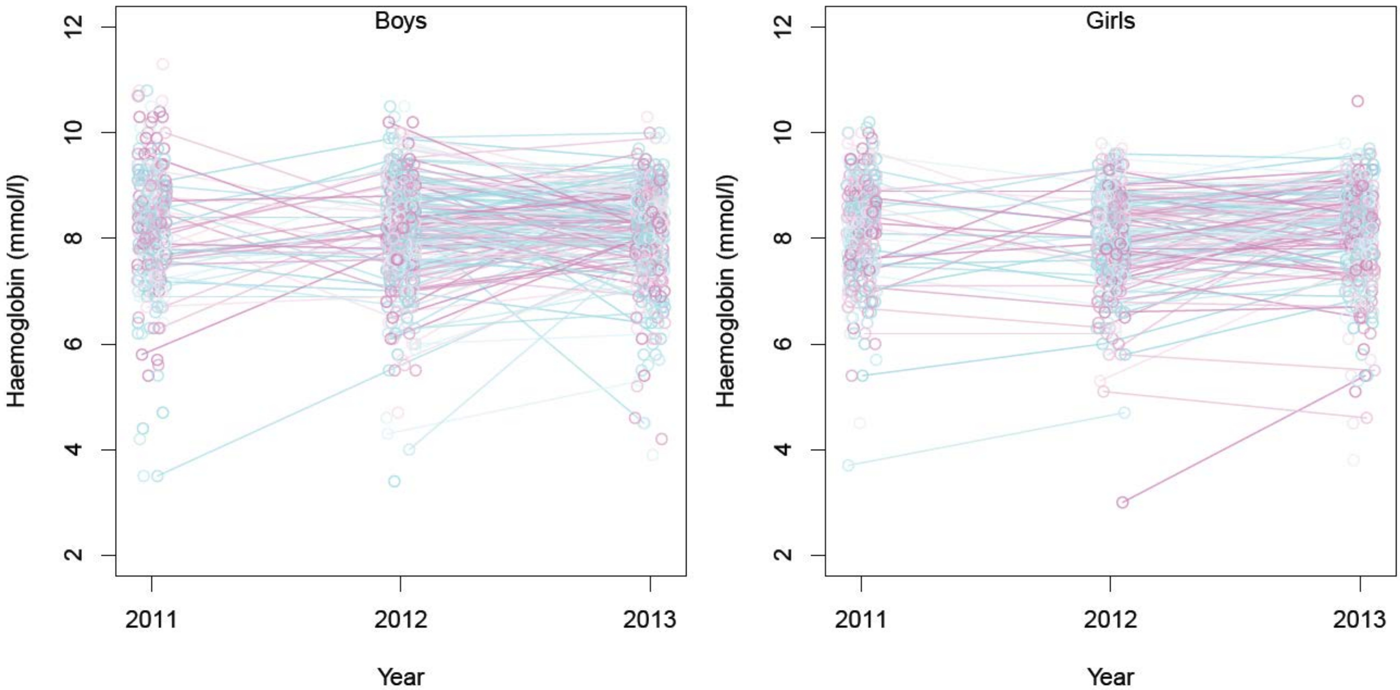
School / area (altitude considered for determining anaemia)	Number tested in 2013	Number anaemic in 2013	Prevalence of anaemia in 2013	Prevalence of anaemia in 2012	Prevalence of anaemia in 2011
Total	835	150 (481)	18% (58%)		
Lamdon School Diskit (2000m)	182	22 (78)	12% (43%)	16% (50%)	N/A
Model School Diskit (2000m)	28	2 (10)	7% (36%)	N/A	N/A
Turtuk (1500m)	108	35 (53)	32% (49%)	N/A	N/A
Lamdon School Sumoor (2000m)	158	31 (94)	20% (60%)	N/A	N/A
Government School Sumoor (2000m)	17	7 (11)	41% (65%)	N/A	N/A
Alchi Institute (2000m)	69	11 (46)	16% (67%)	19% (76%)	25% (69%)
Riglam School (2000m)	64	11 (46)	17% (72%)	27% (84%)	16% (80%)
BVN School (2000m)	42	6 (29)	14% (69%)	18% (80%)	16% (65%)
Police Public School (2000m)	36	7 (25)	19% (69%)	N/A	N/A
Druk White Lotus School (2000m)	131	18 (89)	14% (68%)	32% (85%)	23% (85%)

In 2013, 36% (81%) of infants up to age one were anaemic, and likewise 22% (63%) in children between 1 and 5 years of age, 18% (56%) in children between 5 and 7 years of age, and 13% (60%) in children of age 8 or higher.

Overall, about one fifth of the checked children had low levels of haemoglobin. Because the diagnosis of anaemia was based on less strict criteria than last year, we also recalculated prevalence of anaemia for the previous years (Table 4). Obviously, the choice of criteria for anaemia substantially influence the prevalence of anaemia; according to the strict criteria (also used in 2011 and 2012), 58% of children were anaemic, whereas according to the less strict criteria (used this year for the first time), only 18% were anaemic. As discussed earlier, the strict criteria are probably too strict (i.e. overestimate prevalence of anaemia), as they completely mask the expected age-pattern in anaemia (high prevalence among younger children). However, we are also unsure whether the less strict criteria that were applied this year are entirely appropriate (e.g. they may underestimate the prevalence of anaemia). Therefore, there is an urgent need to establish accurate, standard values for haemoglobin in children at high altitude, given optimal nutritional conditions.

If anything, prevalence anaemia has declined slightly between 2012 and 2013. Given that in 2013 the checked children were somewhat younger that in 2012, and prevalence of anaemia is generally higher in younger children, we conclude that that MCC mission of 2012 has had a beneficial effect on Hb levels of children through health education, deworming, and/or treatment. To rule out that this apparent decline in anaemia was due to selection of different population of children over the years, we compared Hb levels of children who were checked both in 2012 and 2013. In general, Hb levels changed a lot between 2012 and 2013, both upwards and downwards, and no positive trend was found between 2012 and 2013 (Figure 6). However, we found that between 2012 and 2013, Hb levels had increased significantly more in children who had received iron supplementation in 2012 (0.8 mmol/l extra on average), compared to untreated children. This supports the notion that three months of iron supplementation can support the Hb production in a child for a full year. Still, children treated with iron in 2012 still had relatively low Hb levels in 2013, compared to children who did not need treatment in 2012, meaning these children are vulnerable to re-developing anaemia. The treatment effect was much smaller (0.2 mmol/l extra on average) and not significant in multivitamin-treated children (vitamin B1, B6, and B12). Multivitamins may also be beneficial, but their effect may not last as long as that of iron. Furthermore, multivitamin-treated children were generally less anaemic in 2012, so the gain in their Hb levels was expected to be lower than in iron-treated children.

Figure 6: Follow-up of haemoglobin levels in children from 2011 to 2013. Open circles represent individual children; lines connect repeated measurements in the individual children over the years.



Possible remedies for anaemia are: 1) better nutrition, including more vegetables and fruit in the daily diet; 2) treat and prevent intestinal worm infection (hand washing), especially in children under five; 3) introduction of solid food in a baby's diet at six months of age (especially vegetables and fruits!); 4) avoiding sugary, fatty, and refined foods, and instead eating fresh products (in winter: dried, stored, pickled, or canned fresh products); 5) educate children, teachers, and parents about the above. When we diagnosed anaemia in a child, the standard treatment was iron suppletion, which was given for three months. If a baby was anaemic, multivitamin drops were prescribed for the baby and iron supplements for the mother. In addition, we tried to educate children, teachers, and guardians about the importance of preventing anaemia, and how to do it.

Table 5: Disease in the examined children, per school / area (number of cases and prevalence in parentheses).

	Active worm inf.	Caries with pain	Scabies	Vitamin deficient	Pneumonia	Pathologic heart murmur
Lamdon School Diskit	0 (0.0%)	53 (29%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Model School Diskit	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Turtuk	2 (1.9%)	1 (<1%)	1 (<1%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Lamdon School Sumoor	0 (0.0%)	27 (17%)	0 (0.0%)	0 (0.0%)	3 (5.5%)	0 (0.0%)
Government School Sumoor	0 (0.0%)	5 (29%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (5.9%)
Alchi Institute	1 (1.4%)	18 (26%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Riglam School	0 (0.0%)	17 (27%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
BVN School	1 (2.4%)	4 (9.5%)	0 (0.0%)	1 (2.4%)	0 (0.0%)	0 (0.0%)
Police Public School	0 (0.0%)	3 (8.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (2.8%)
Druk White Lotus School	0 (0.0%)	13 (9.9%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (<1%)
Total	4 (<1%)	141 (17%)	1 (<1%)	1 (<1%)	3 (<1%)	3 (<1%)

Worm infections

Intestinal worm infections are an important cause of anaemia and growth retardation in developing area. Intestinal worm infection can be contracted by contact with stools or soil that is contaminated with worm eggs (oral or skin contact such as walking bare feet). Soil becomes contaminated by stools of infected persons (i.e., lack of sanitation). Worm eggs in contaminated soil stay infective for years. A major preventive measure for worm infection (and concomitant anaemia) is hygiene: washing of hands with soap after toilet visits and before meals or preparation of food; enclosed, clean toilet facilities; hygienic food preparation; combined with treatment of active worm infections (bloated bellies; see a doctor) and preventive treatment of all children of age 2 to 12 with albendazol (400 mg) or mebendazol (200 mg) twice a year. Preventive treatment is most important for children under five.

In the Ladakh region, we identified four suspected cases of major worm infection (bloated belly), all of age five and lower. Because without examination of stool, major worm infection is a difficult, subjective diagnose, it is likely that there were more sub-clinical cases of worm infection. Earlier, we hypothesized that the low prevalence of worm infection may have been due to the typical Ladakhi toilet, which is clean by its nature and may prevent worm infections. This may still hold. On the other hand, there may still be many children with intestinal worms who remained undetected during our checks, given the lack of a regular anti-worm treatment program. Also, in areas where it is custom to fertilize the land with human excrements from the Ladakhi toilets, foods grown on such lands may be contaminated with worm eggs. Therefore, all checked children were given preventive treatment (albendazol 400 mg; expect at the Druk White Lotus school where hostel children had recently been treated already). We recommend that all schools repeat this treatment after twelve months.

Pneumonia and tuberculosis

Pneumonia and tuberculosis are still on the list of leading causes of child mortality. A total of three children were diagnosed with pneumonia and treated with antibiotics. No cases of suspected tuberculosis were seen. The number of children with pneumonia and tuberculosis was surprisingly low compared to previous missions in Spiti, a region that is comparable to Ladakh in terms of climate and school and health system. This difference may indicate that Ladakhi children are generally healthier. Last year's findings were similar.

Pathologic heart murmurs

Thirteen children had audible heart murmurs, most of which were associated with severe anaemia. Three cases were suspected of having a pathological heart murmur, i.e. a murmur due to a structural heart deficit. All children were referred for check-up by a dentist (a pathologic heart murmur combined with bad dental condition may lead to rheumatic valve disease) and were sent to the paediatrician at the government hospital.

Caries

Dental health is important for the well being of children in several ways. Low dental health may lead to inflammation and pain, which in turn may lead to reduced appetite (important for anaemia and growth retardation), reduced ability to concentrate in class, and even rheumatic heart disease in children with heart valve defects (heart murmur).

Because this year, the MCC was without dentists, we referred all children with dental pain to either the army dental camp in Nubra valley, or the dental surgery unit of the government hospital in Leh. In general, the dental health and hygiene in children was very low in all schools. In general, 17% of children reported having tooth pain. Tooth pain was generally more common in affluent areas / schools, most likely due to higher consumption of sugar-containing foods and drinks in the Indus valley, associated with its urbanization. Many of the children indicated that they only brushed once a day before breakfast. Children who remembered learning to brush twice a day last year often indicated that they brushed before breakfast and before dinner (rather than after breakfast and after dinner).

We advice the following for improvement of dental health of children. Some of these advices were already discussed with school boards during the mission. 1) Ban sweets from school grounds. 2) For hostel students, schedule moment for tooth brushing at school in the morning after breakfast and before the daily opening ceremony. 3) Assign upper class students in school as tooth-brushing mentor for younger children in the school, so that they may instruct and help the younger children brushing their teeth. 4) Schedule moment for tooth brushing in the evening after dinner for those children staying at school hostels, making hostel mothers responsible for supervision of the tooth brushing. 5) Children should use toothpaste that contains fluoride and schools supplying toothpaste to their students should check this. 6) Children should start tooth brushing as soon as the first teeth appear (so they get used to it). Children under six are not skilled enough to brush their teeth themselves and should be helped by their parents/guardians. 7) Educate children and parents/guardians about the importance of dental health.

Referrals

We referred six children to the nearest hospital for follow-up of severe anaemia (Hb < 5.5 mmol/l), three children for heart ultrasound because of suspected heart valve defects, one child for follow-up of a perforated ear-drum, and several children for eye testing (suspected refraction error).

Findings from interactive health education session

From our interactive health education sessions with children and their guardians we learned that it is common practice to wash hands after meals, as meals are often taken by hand and food residues need to be washed off. This custom sometimes prevents children and guardians from understanding why hands should also be washed before meals (and before preparing meals). Therefore, during the health education sessions, we emphasised that washing hands before meals prevents the spread of germs and disease.

We also learned that some children picked up the habit of brushing the teeth twice a day, as instructed last year. However, some of them only brushed their teeth before meals (breakfast and/or dinner). Therefore, this year we again emphasized the importance of brushing teeth after meals. An often heard explanation for not brushing teeth after dinner was that children usually fell asleep after dinner and were too tired as the family usually had dinner late (eight to nine o'clock in the evening).

As mentioned before, many children do not like vegetables, probably because parents only offer their children vegetables on a regular basis when they are at least five year old. We recommend that parents feed their babies vegetables and fried from the age of six months onwards, in addition to breast-feeding (which should be continued up to age one and a half to two years, as is current practice).

Conclusions

- In general, in Ladakh there is a strong need for comprehensive and systematic health promotion and preventive measures. Special emphasis needs to be put on hand washing (after toilet, before dinner or preparing food), tooth brushing (after breakfast and after dinner), good eating habits (avoid Maggi, cookies, sweets, and chocolate) and nutritious food (vegetables and fruits from the age of six months onwards).
- The situation of child health is particularly poor in government schools and remote areas. Private schools generally have more resources and personnel to improve children's health. Therefore, next year we intend to focus more on government schools and remote areas.
- We challenge private schools to take the health of their children to the next level themselves by:
    - Taking up hand-washing (before meals) and tooth-brushing (after meals) as fixed parts of the daily routine of hostel children.
    - Taking up hand-washing and tooth-brushing as standard learning subjects of the curriculum.
    - Providing facilities where children can wash hands (and brush teeth for hostel children).
    - Recording the children's age in a central registry and/or on an identity card.
    - Annually de-worming all children of age two and above with a single dose of albendazole 400 mg.
    - Organize parent meetings on child health at least once a year.
    - Banning sweets from the school grounds.
    - Providing double servings of vegetables for children's lunch meals at schools (current servings of vegetables at school are much too small!).
    - Set up vitamin programs for children during the winter.
    - Measure and weigh their students at least once a year (e.g. by school nurse). While measuring height, care should be taken that students take off shoes and caps, stand with the heels and head against the wall, stretched knees, and that a book (or similar straight object) is put on the head of the student perpendicular to the wall (i.e. at 90 degrees). Appendices B and C (at the end of this document) provide minimum values for weight and height, given age, and minimum values for weight, given height. Weight or height under the minimum for age may indicate chronic illness or poor nutrition over a long time and require doctor

consultation. Weight under the minimum for a given height may indicate acute malnutrition or severe illness and requires doctor consultation.
  - MCC is most willing to advise schools in the above matters (please contact us through www.medicalchecksforchildren.org).
- As far as we know, there is no vitamin A program in the Ladakh region. In recent years, scientists have found that vitamin A supplementation lowers child mortality. We therefore, like last year, again urge the Ladakh Autonomous Hill Development Council to consider such a program. Medical Checks for Children would be happy to advice in the matter.
- We recommend that during the winter, children are given vitamin supplements. Results from this mission show that vitamin supplementation during winter has beneficial effects on children's weight, and therefore probably also their general development.
- There is an urgent need to establish standard growth curves and minimum haemoglobin levels for children living at altitude. Without such standards, it is difficult to establish to what extent Ladakhi children are growing well or not. Until such new standards are established, we recommend the use of the standard international growth curves (Appendix B and C).

Last words

We would like to emphasize that the mission of MCC is to sustainably improve child health. We want to achieve this goal by empowering children, parents, guardians, and local health systems, increasing their knowledge about health and access to healthcare. We do not want to achieve this goal by indefinitely handing out medicine, as this will only make people dependent, rather than empowering them to improve their health themselves. In other words, the medical camps that we organize are not a goal by themselves, but a means to identify what is keeping children from developing into their full potential. In the process we provide basic health care, but as said, this is not the primary goal. Therefore, in our collaboration with local partners and schools, we expect reciprocity, meaning that we would like to see that local partners and schools take responsibility for the health of the children and undertake action to improve it. If they do not undertake action or have little interest in participating in MCC's medical camps, there is little reason for MCC to collaborate with them in the future. We anticipate that as the years will pass and the dangers to child health in Ladakh are identified, MCC will take on a more advisory role, such that schools, communities, and the health system in Ladakh do not become dependent on MCC activities, but rather they themselves undertake action. We sincerely hope that the Ladakh Autonomous Hill Development Council can appreciate and support this vision.

Having said this, we are grateful to all the schools, parents, care takers and community people for bringing the children and helping to conduct the program. We are happy we got the opportunity to work with and to learn from all volunteers, translators and other supporting members who have helped directly or indirectly, despite their own obligations. We are looking forward to revisiting Ladakh in 2014.

We further would like to thank our local partners Ad van Beckhoven, Tashi Palzom, Nordan Otzer, and Dawa Sonam for their commitment and flexibility. Their efforts have made it possible for MCC to organize medical camps in Ladakh during the last three years. We further acknowledge the flexibility of the Druk White Lotus School to host an unplanned medical camp this year.

We enjoyed working together with the teachers, health workers and senior students of all the schools that we visited. We hope they will continue to inspire their communities in the same way they inspired us. They play a vital role in spreading awareness and knowledge about health and its importance for children in reaching their full potential. And last but not least, we would like to thank the children who came to the checks for their inspiring presence.

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Mission leader MCC mission Ladakh 2013
Leh, 24th of June, 2013

Appendix A: Criteria for anaemia

Table A1: Minimum haemoglobin levels in children, used to determine presence of anaemia (i.e. haemoglobin levels under the minimum) during MCC missions. During previous MCC mission (2011, 2012), the actual (approximate) height of residence was used (e.g. 3500m for children from Leh). However, this approach possibly led to an overestimation of the prevalence of anaemia (see main text for details). Therefore, during the 2013 mission, we used the minimum haemoglobin values that supposedly hold for 2000m (with the exception of Turtuk village, for which we used 1500m). This approach is also more in line with the current practice of local medical doctors who handle the minimum haemoglobin level of 110 gr/l for diagnosing anaemia in children.

Gender	Age	Minimum haemoglobin level in mmol/l and gr/l (in parentheses), given altitude of residence[2]								
		Sea-level	1000m	1500m	2000m	2500m	3000m	3500m	4000m	4500m
Any	0.5–2	6.4 (103)	6.5 (105)	6.7 (108)	6.9 (111)	7.2 (116)	7.6 (122)	8.1 (130)	8.6 (138)	9.2 (148)
	2–4	6.8 (110)	6.9 (112)	7.1 (115)	7.3 (118)	7.6 (123)	8.0 (129)	8.5 (137)	9.0 (145)	9.6 (155)
	5–7	7.0 (113)	7.1 (115)	7.3 (118)	7.5 (121)	7.8 (126)	8.2 (132)	8.7 (140)	9.2 (148)	9.8 (158)
	8–11	7.2 (116)	7.3 (118)	7.5 (121)	7.7 (124)	8.0 (129)	8.4 (135)	8.9 (143)	9.4 (151)	10.0 (161)
Girl	12–14	7.2 (116)	7.3 (118)	7.5 (121)	7.7 (124)	8.0 (129)	8.4 (135)	8.9 (143)	9.4 (151)	10.0 (161)
	15–17	7.2 (116)	7.3 (118)	7.5 (121)	7.7 (124)	8.0 (129)	8.4 (135)	8.9 (143)	9.4 (151)	10.0 (161)
Boy	12–14	7.4 (119)	7.5 (121)	7.7 (124)	7.9 (127)	8.2 (132)	8.6 (138)	9.1 (146)	9.6 (154)	10.2 (164)
	15–17	7.6 (122)	7.7 (124)	7.9 (127)	8.1 (130)	8.4 (135)	8.8 (141)	9.3 (149)	9.8 (157)	10.4 (167)

[2] Sea-level minimum values were based on *CDC criteria for anaemia in children and childbearing age women*. MMWR, 1989, 38:400-404. Adjustments for high altitude were adapted from Hurtado et al. *Influence of anoxemia on haematopoietic activities.* Archives of Internal Medicine, 1945 75:284-323.

Appendix B: Minimum values for height and weight, given age

	Minimum height (cm) given age			Minimum weight (kg) given age	
Age in (years:months)	Boys	Girls	Age in (years:months)	Boys	Girls
0:0	46.3	45.6	0:0	2.5	2.4
0:6	63.6	61.5	0:6	6.4	5.8
1:0	71.3	69.2	1:0	7.8	7.1
1:6	77.2	75.2	1:6	8.9	8.2
2:0	82.2	80.3	2:0	9.8	9.2
2:6	85.5	84.0	2:6	10.7	10.1
3:0	89.1	87.9	3:0	11.4	11.0
3:6	92.4	91.4	3:6	12.2	11.8
4:0	95.4	94.6	4:0	12.9	12.5
4:6	98.4	97.6	4:6	13.6	13.2
5:0	101.2	100.5	5:0	14.3	14.0
5:6	104.0	102.9	5:6	15.3	14.9
6:0	106.7	105.5	6:0	16.1	15.4
7:0	111.8	110.5	7:0	17.9	17.0
8:0	116.6	115.7	8:0	19.8	19.0
9:0	121.3	121.0	9:0	21.6	21.1
10:0	125.8	126.6	10:0	23.6	23.8
11:0	130.9	132.5			
12:0	135.8	138.4			
13:0	142.1	143.3			
14:0	148.7	146.7			
15:0	154.3	148.7			
16:0	158.3	149.8			
17:0	160.8	150.3			
18:0	162.1	150.6			
19:0	162.8	150.9			

Appendix C: Minimum values for weight, given height

	Minimum weight (kg) given height	
Height (cm)	Boys	Girls
46	2.2	2.2
48	2.5	2.5
50	**2.8**	**2.8**
52	3.2	3.2
54	3.6	3.6
56	4.1	4.1
58	4.6	4.5
60	**5.1**	**5.0**
62	5.6	5.4
64	6.0	5.8
66	6.5	6.2
68	6.9	6.6
70	**7.2**	**6.9**
72	7.6	7.3
74	8.0	7.6
76	8.3	7.9
78	8.7	8.2
80	**9.0**	**8.6**
82	9.3	8.9
84	9.7	9.3
86	10.1	9.8
88	10.6	10.2
90	**11.0**	**10.6**
92	11.4	11.0
94	11.8	11.4
96	12.2	11.9
98	12.6	12.3
100	**13.0**	**12.7**
102	13.5	13.2
104	14.0	13.7
106	14.5	14.3
108	15.0	14.8
110	**15.6**	**15.4**
112	16.3	16.3
114	17.0	17.0
116	17.6	17.7
118	18.2	18.4
120	**18.8**	**19.1**