

## STUDIES ON PREVENTIVE NEPHROLOGY: SYSTEMIC HYPERTENSION IN THE PEDIATRIC AND ADOLESCENT POPULATION OF GASSIM, SAUDI ARABIA

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Casual blood pressure was recorded for subjects of Faizia East Primary Health District during a cross-sectional population survey. Valid information was obtained from 5671 subjects, out of which 3299 (1561 males and 1738 females) were between the ages of three and 18, constituting therefore the pediatric/adolescent (P/A) sector of our study population. The prevalence of hypertension (HPN), defined as  $\geq 95$ th percentile for total HPN population (mild and severe) and  $\geq 99$ th percentile for severe, was calculated for the three-year age cohorts suggested by the Task Force on Blood Pressure Control in Children (1987). The three subsets of HPN were derived from the suggested cut-off levels without any modifications. Overall prevalence of HPN was, for the P/A, found to be 10.65% (351/3299). Females in all the age cohorts were significantly more hypertensive than males, overall gender prevalence being 7.94% (124/1561) for males against 13.06% (227/1738) for females:  $P=0.0000019$ ; CI:  $0.45 < OR < 0.73$ . One hundred and twenty-eight subjects (3.88%) had severe HPN, again with gender difference in favor of females (2.57 versus 5.06%),  $P=0.00022$ ; CI:  $0.33 < OR < 0.74$ . Sixty-seven and a half percent (237/351) of the HPN population were in the six to 12 year age group, with the significant gender difference persisting ( $P=0.000407$ ; CI:  $0.41 < OR < 0.74$ ). Ninety-four of these (73.44%) had the severe HPN, with similarly significant gender difference ( $P=0.0018$ ; CI:  $0.31 < OR < 0.79$ ). Significantly, 67% of gross proteinuria for the entire population has been found in the same age cohort with the same significant gender difference. ISHPN was found to constitute 51.57% (181/351) of the HPN population, followed by IDHPN with 32.48% (114/351) and S/DHPN the least with 15.95% (56/351). The significant gender difference in favor of females noted seems to be unique to the Saudi population. Similarly, the preponderance of ISHPN subsets is, to our knowledge, being recorded from the first time in literature. When coupled with the pattern of proteinuria, we believe that, in the context of preventive nephrology, greater attention will need to be devoted to the pediatric population, especially females. *Ann Saudi Med* 1997;17(1): 47-52.

It is universally accepted that systemic hypertension (HPN) is a distinct risk factor for cardiovascular diseases, particularly left ventricular failure, myocardial infarction and stroke, as well as for chronic renal damage.<sup>1-6</sup> Its early detection and control is accompanied by decrease in the severity and incidence of the target organ damage,<sup>1</sup> except perhaps end-stage renal failure (ESRF), according to some reports.<sup>7</sup> It is therefore useful to determine its prevalence for any given community, not only because it varies from one community to the other, from race to race, but also because it is essential for identifying the population at risk and for the overall planning of medical

can be initiated by elevated blood pressure. Further, in Saudi Arabia, the prevalence and pattern of systemic hypertension remains to be defined for the adult as well as for the pediatric/adolescent population. Therefore, as part of the initial program in our studies on preventive nephrology, we have recorded the casual blood pressure in a sample of Gassim population by a cross-sectional total population survey. We report our findings in the pediatric and adolescent sector of the community. As far as we know, this is being undertaken for the first time in Saudi Arabia.

### Material and Methods

The sample used was the total population of the Faizia East Primary Health District (FEPHD), which is one of the 14 serving Buraidah, the capital of the Gassim region of

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Accepted for publication 25 May 1996. Received 5 November 1995. care. Part of our goal in preventive nephrology is the early detection and prevention of nephron damage, which

Saudi Arabia. The district is divided into two environmentally distinct sections: Block B, which is well planned and urbanized with all modern facilities and Labdia, which is semirural, randomly developed, dusty, without planned roads and largely inhabited by bedouins who live adjacent to and sometimes in the same enclosure as their livestock.

A cross-sectional total population survey of the district was carried out, moving from house to house. In every household, subjects were taught self-urinalysis, using the dip stix technique (Borrhinger-Mannheim). Each individual's interpretation of color change for proteinuria and glycosuria was recorded after correction, if necessary. Height and weight (using an ordinary bathroom scale) were recorded. Blood pressure was recorded for all subjects in whom it was feasible, in the home environment, after adequate rest, using standard mercury sphygmomanometer with bladder cuff size 18.5 cm x 9.5 cm for the smaller arms and 23.5 cm x 12.5 cm for the larger arms. The recording was taken in the sitting position, with the exposed (except for females, where light clothing was allowed between the skin and the cuff) right arm outstretched on a table. Children sat on a parent's lap while the examiner's left arm supported their right arm for the blood pressure recording. Systolic blood pressure was recorded at Korotkoff I and diastolic at Korotkoff V. When the latter persisted to zero, the diastolic pressure was designated as unrecordable and marked 1 for the purposes of data analysis to distinguish it from 0, which denoted no record or no information. In this exercise, in order to avoid confusion and enhance comparability of results, we have avoided using Korotkoff IV, which has more of a subjective judgment than V. As much as was practicable, we adhered to the guidelines suggested by the Working Party on Blood Pressure Recording of the British Hypertension Society.<sup>8</sup> For every subject, the initial reading was recorded except when both or either component of blood pressure was 140/90 mm Hg or higher. In such subjects, the cuff was completely deflated and a second reading taken after a short rest—about 20 seconds. The average of the two readings was recorded as the casual reading for the individual. Although convenient for the field circumstances, using the level of 140/90 mm Hg to determine when to take a second reading means that for all pediatric age cohorts and most of the adolescents, only the initial reading was used to compute the prevalence of HNP. Blood pressure was recorded almost entirely by only one doctor (MAOS), in order to ensure uniformity of recording. On those fortunately few occasions when it was not practical for him to record—e.g., if a female subject insisted on her record being taken by a nursing sister—the survey team repeatedly viewed, queried and discussed the video cassette "Blood Pressure Recording" by the Working

Party. All members carried out the exercise contained therein.

Data were entered into the personal computer using the dBase 4 program. Data analysis was done by SPSS for DOS and EPI5 programs as appropriate. Odds ratios (OR), Cornfield 95% confidence interval (CI) and chi-squared ( $\chi^2$ ) (uncorrected or Yates corrected), with corresponding *P*-values, were calculated with the EPI5 program, which was kindly supplied free of charge by the Director General of the WHO.

HPN for each of the age cohorts we report, that is, 3-5, 6-9, 10-12, 13-15, and 16-18 years, was defined according to the recommendation of the Task Force on Blood Pressure in Children (TFBPC), 1987,<sup>9</sup> using blood pressure levels  $\geq 95$ th and  $\geq 99$ th percentiles as shown in the appropriate text below. Results were analyzed to test for effects due to gender and location of residence of the subjects.

For each age cohort, the hypertensive population was categorized into the three subsets of systemic hypertension, namely, combined systolic/diastolic hypertension (S/DHPN), isolated systolic (ISHPN) and isolated diastolic hypertension (IDHPN). For this purpose, we did not alter the defining cut-off levels of blood pressure in any way.

## Results

Out of a total *de facto* population of 7695 surveyed, blood pressure could be recorded in 5671 subjects. The bulk of the population whose records could not be taken were infants and children below the age of three years. Our report has accordingly not included this age group. A total of 3299 subjects (1561 males and 1738 females) between the ages of three and 18 years had their blood pressure recorded.

### *Three to five years*

In this age group, 659 subjects (328 males and 331 females) had their blood pressure recorded. Using the TFBPC definition, 49 subjects (20 males and 29 females) were found to have HPN ( $\geq 116/76$ , 95th percentile), giving an overall of 7.44%. The bulk of this population of hypertensives was in the ISHPN subset, 29 out of 49 (59.18%). The other two subsets—S/DHPN and IDHPN—had 10 (20.41%) each. It is noted that the prevalence in females, in all but one of the three subsets (IDHPN where it is equal) is decidedly higher than in males. Overall, it was 8.76% in females compared with 6.04% in males but the difference did not achieve statistical significance. Only 11 out of the 49 (22.45%) hypertensives fell into the severe HPN ( $\geq 124/84$ ; 99th percentile) group, giving a prevalence of 1.67% for this age cohort. What is striking is that 10 (90.91%) from this

severe hypertensive population were female. Another observation is that none of the 11 subjects had the traditional combined systolic and diastolic hypertension (S/DHPN). Seven out of the 11 (63.63%) had ISHPN, while four (36.36%) had IDHPN. The gender difference in this subgroup did achieve statistical significance—OR: 0.10; chi-squared=7.41;  $P=0.0065$ ; CI:  $0.0 < OR < 0.75$ .

#### *Six to nine years*

In this cohort, 970 subjects (477 males and 493 females) were examined. Out of this number, a total of 145 (14.95%) had HPN ( $\geq 122/78$ , 95th percentile). Eighty-six were females and 59 males. Again, in all three categories of HPN, the prevalence in the female gender was decidedly higher than in males—3.65% versus 1.68%, 5.27% versus 3.35%, and 8.52% versus 7.34% respectively for S/DHPN, ISHPN and IDHPN. The overall gender prevalence was 17.44% for females and 12.37% for males, with the difference reaching statistical significance—OR: 0.67; chi-squared=4.91;  $P=0.03$ ; CI:  $0.46 < OR < 0.97$ . In this cohort, the bulk of the hypertensive population was in the IDHPN subset—77/145 (53.10%). Each of ISHPN and S/DHPN had 42 (28.97%) and 26 (17.93%) respectively.

Severe HPN ( $\geq 130/86$ , 99th percentile) was recorded in 59 out of the 145 (40.69%) hypertensives in this age cohort. Twenty-two were males and 37 were females. In this group also, females remained consistently more hypertensive than males in all the categories of HPN. The gender difference was, however, not statistically significant—OR: 0.60; chi-squared=3.55;  $P=0.59$ ; CI:  $0.33 < OR < 1.06$ .

#### *10 to 12 years*

In this age group, 726 (348 males and 378 females) had their blood pressure recorded. Ninety-two (12.67) had HPN ( $\geq 126/82$ , 95th percentile). Sixty-five out of these 92 (70.65%) were female and 27 (29.35%) were male. The gender difference in prevalence overall was highly significant—OR: 0.41; chi-squared=14.58;  $P=0.0001$ ; CI:  $0.24 < OR < 0.67$  and was even more significant in the ISHPN subset—OR: 0.26; chi-squared=16.92;  $P=0.00003$ ; CI:  $0.12 < OR < 0.54$ .

Out of the hypertensives, 35 (38.04%) subjects had severe HPN ( $\geq 134/90$ , 99th percentile). Only nine were male, while 26 were female. In keeping with the trend observed in the previous groups, prevalence in females is higher than in males, reaching statistical significance in the category of ISHPN—OR: 0.20; chi-squared=8.08;  $P=0.004$ ; CI:  $0.05 < OR < 0.72$ .

#### *13 to 15 years*

In this age group, 558 (237 males and 321 females) had their blood pressure recorded. Forty-eight (8.6%), made up of 13 males and 35 females, were found to have

HPN ( $\geq 136/86$ , 95th percentile). None of these had the S/DHPN and the majority—42 out of 48 (87.5%)—had ISHPN, while the remaining six (12.5%) had IDHPN. The gender difference in prevalence remains in favor of females and reached statistical significance overall—OR: 0.47; chi-squared=5.09;  $P=0.02$ ; CI:  $0.23 < OR < 0.96$ —and in the ISHPN category—OR: 0.40; chi-squared=6.47;  $P=0.01$ ; CI:  $0.18 < OR < 0.86$ .

Fifteen of the 48 had severe HPN ( $\geq 144/92$ , 99th percentile), with 11 being female and four being male. Virtually all (14 out of 15) had ISHPN. The remaining one had IDHPN.

#### *16 to 18 years*

A total of 386 (171 males and 215 females) subjects were surveyed in this age cohort. Seventeen (4.42%) were found to be hypertensive ( $\geq 142/92$ ; 95th percentile). Twelve were female and five were male. Again, most subjects had the ISHPN—15 out of 17. Only one female had the S/DHPN and another female the IDHPN.

Eight of the 17 were found to have severe HPN ( $\geq 150/98$ , 99th percentile). One subject, a female, had S/DHPN, while the remaining seven had ISHPN. It is only in this group of hypertensives among the adolescent age that the gender prevalence was higher in males than females (overall 2.34% versus 1.86%). That is the gender pattern which has begun to move toward the adult trend.

Tables 1 and 2 give the summary of our findings. Out of a total of 3299 subjects, aged between three and 18 years inclusive, 351 were found to have their casual blood pressure readings equal to and above the 95th percentile level as defined by TFBPC (1987), giving an overall prevalence of 10.64% for the population. The overall gender prevalence of 7.94% for males and 13.06% for females showed a highly significant difference in favor of females—OR: 0.57; chi-squared=22.65;  $P=0.0000019$ ; CI:  $0.45 < OR < 0.73$ . Over half (1696/3299:51.41%) of this population are in the six- to 12-year age group, which also reflect this highly significant tendency for girls to be more hypertensive than boys—OR: 0.55; chi-squared=16.84;  $P=0.000041$ ; CI:  $0.41 < OR < 0.74$ .

Casual blood pressure levels equal to and above the 99th percentile were recorded in a total of 128 (40 male and 88 female) subjects. As with the total hypertensive population, the gender difference in the group with severe HPN was also significant—OR: 0.50; chi-squared=13.63;  $P=0.00022$ ; CI:  $0.33 < OR < 0.74$ . Ninety-eight (31 male and 63 female) (68.75%) (98/128)—were in the six- to 12-year age group and they, too, reflected the significant gender difference (OR: 0.31; chi-squared=9.78;  $P=0.0018$ ; CI:  $0.31 < OR < 0.79$ ). When the total hypertensive population is broken into the three subsets (Table 3),

TABLE 1. Faizia East PHD, Buraidah, systemic hypertension (HPN) in pediatric & adolescent groups.

Age group	≥95th percentile					
	Male		Female		Total	
	Normal	HPN	Normal	HPN	Normal	HPN
3-5	308	20	302	29	610	49
6-9	418	59	407	86	825	145
10-12	321	27	313	65	634	92
13-15	224	13	286	35	510	48
16-18	166	5	203	12	369	17
Total	1437	124	1511	227	2948	351
%	7.94		13.06		10.64	

Total: OR: 0.57; chi-squared: 22.65; P=0.000019; CI: 0.45<OR<0.73; 6-12 years: OR: 0.55; chi-squared: 16.84; P=0.0000407; CI: 0.41<OR<0.74.

TABLE 3. Faizia East PHD, Buraidah, systemic hypertension (HPN) in pediatric & adolescent groups.

Age group	≥95th percentile			Total
	Summary - 3 categories of HPN			
	ISHPN	IDHPN	S/DHPN	
3-5	29	10	10	49
6-9	42	77	26	145
10-12	53	20	19	92
13-15	42	6	0	48
16-18	15	1	1	17
Total	181	114	56	351
%	51.57	32.48	15.95	

ISHPN was found to constitute over half (181/351: 51.57%), followed by IDHPN (114/351: 32.48%) and S/DHPN (56/351: 15.95%). The overall prevalence of the individual subsets are as follows: ISHPN 5.49% (181/3299); IDHPN 3.46% (114/3299); S/DHPN 1.7% (56/3299).

For this exercise, we note that no subject in the pediatric and adolescent age groups admitted to current antihypertensive therapy.

### Discussion

The prevalence of HPN in Saudi Arabia has not been fully defined for any sector of the population. In particular, for the pediatric and adolescent sectors of the population, we have not been able to find any studies in Saudi medical literature. In other reports, the prevalence in this age group has been found to vary from 2% to 13% at the initial screening.<sup>11</sup> Differences have been reported when race, skin color and socioeconomic stress<sup>13,14,16</sup> were

TABLE 2. Faizia East PHD, Buraidah, systemic hypertension (HPN) in pediatric & adolescent groups.

≥99th percentile

Age group	Male		Female		Total	
	Normal	HPN	Normal	HPN	Normal	HPN
3-5	321	1	321	10	648	11
6-9	455	22	456	37	911	59
10-12	339	9	352	26	691	35
13-15	233	4	310	11	543	15
16-18	167	4	211	4	378	8
Total	1515	40	1650	88	3171	128
%	2.57		5.06		3.88	

Total: OR: 0.50; chi-squared: 13.63; P=0.00022; CI: 0.33<OR<0.74; 6-12 years: OR: 0.50; chi-squared: 9.78; P=0.0018; CI: 0.31<OR<0.79.

examined. In all these studies, it has been difficult for us to compare our figures with those reported, because we could not be sure which subsets of the respective hypertensive population were included in or excluded from the calculations. We have found an overall prevalence of HPN (including mild and severe) to be 10.64%, based on a casual reading. Presumably, therefore, this must be the maximum figure that can be expected in our study community. Repeated readings will almost certainly produce lower figures.<sup>12</sup> The breakdown of our HPN population into the three subsets shows that if we considered only the S/DHPN, our figure of 1.7% would compare with the 2% referred to above. If diastolic hypertension, as is quite often done, were used as the sole criterion, our figures would be a maximum of 5.16% (S/DHPN 1.7% + IDHPN 3.46%). Clearly, in our view, some clarity in the presentation of prevalence figures will enhance comparability of various studies. We also believe that such an approach may lead to better understanding of the prognostic significance of the various subsets of hypertension. In another, as yet unpublished study, we have shown, for example, that the three subsets in our adult study population followed different patterns when distributed into 10-year age cohorts. In most of the previous studies, males have generally been found to be more hypertensive than females.<sup>9,13</sup> Almost without exception, we have found our females to be very significantly more hypertensive than our males. This is quite different from our findings in adults, in whom males tended to be more hypertensive than females, although with marginal or no statistical significance in most of the subsets of HPN. In the same population, we have also found that mean systolic and diastolic blood pressure readings are significantly higher in females than in males. We cannot find a ready explanation for this phenomenon, but environmental, genetic and hormonal factors will all need to be carefully considered. It is possible that cultural values restrict the physical activity in females more than in males, leading to a tendency to obesity. Significantly, mean BMI (body mass index) has been found to be

consistently higher in all age groups in females than males in the same study population. It is difficult to implicate hormonal changes, but it may well be that the lack of such changes in the pediatric female denies them the protection they give older premenopausal members of the gender. The recent discovery of the angiotensin gene<sup>15,16</sup> may also be important. It is more directly related to blood pressure than the ACE gene; its expression is said to be more marked in females and has been found to be more frequent in preeclampsia than in normal pregnancy. The suggestion is that genetically, females should have the higher blood pressure. The final explanation for our findings can only come from further carefully planned studies, but as in all things relating to blood pressure, it has to be multifactorial.

It may be significant that we have found that for all age groups and overall, ISHPN constituted the bulk of the hypertensive population. Indeed, 51.57% (181/351) of all hypertensives had only this category, while 32.48% (114/351) had IDHPN and only 15.95% (56/351) had the combined components. We must emphasize that in our study, we have simplified the definition of ISHPN and the other subsets using the Task Force definitions for each age cohort without modifications. Further, as indicated earlier, Korotkoff V has been used for diastolic pressure in all subjects. Therefore, when added to the fact that only casual screening recordings have been used, our prevalence calculation must represent the maximum possible for our study community. Nonetheless, we believe that this simplified approach is essential for easy comparability of results. As with our earlier remarks on the other subsets, we have found no comparable figures in literature. However, ISHPN in adolescent and young adults is generally thought to be rarer than in the elderly, due to the hyperdynamic state, and may predict the development of diastolic hypertension in the future.<sup>1,9,17,18</sup> In the elderly, it is now established that ISHPN is a definite risk factor for stroke, myocardial infarction and all mortality.<sup>19,20</sup> Such prognostic significance in the pediatric age group remains to be clearly defined, but has been mentioned regarding the effect on the myocardium.<sup>21</sup> It may, however, be significant that in our study, we have found that gross proteinuria was significantly more prevalent in females than in males (six to 12 years, unpublished) in much the same way as HPN (>50% as ISHPN), described above. While this could reflect the presence of secondary renal hypertension, this should not detract from the possible significance of such correlation, which suggests that ISHPN may be associated with nephron damage in the young. We believe that this aspect deserves further clarification. We believe that regular screening in school may yield very rich dividends, although the Task Force does not recommend this.<sup>9</sup> It is pertinent to observe that all but one of the 59 subjects in

our study population whose diastolic blood pressure could not be recorded because Korotkoff V persisted to zero were in the pediatric/adolescent age group. Therefore, the prevalence of ISHPN must have been somewhat distorted but not invalidated. Because the overall prevalence of this group was 1.07% and in the pediatric/adolescent (P/A) group, 1.76% (58/3299), such distortion remains minimal. It is traditional to regard hypertension in the P/A, especially when severe enough, to be of the secondary variety until proved otherwise, but this applies to the hospital-investigated series and even among this catchment group, in over 50% the primary cause cannot be identified.<sup>22,24</sup> When, however, the sample is from the general unselected population, the prevalence of secondary HPN in the P/A cohort is very much lower, being only about 1%.<sup>25</sup> Since our study is in an unselected population, we must presume that most of our HPN population in this age group is of the primary type. Further, the majority of this HPN population—68%—has been found in the six- to 12-year age cohort, the same cohort with 67% of gross proteinuria. It is therefore more likely that the proteinuria has resulted from the HPN and less likely (though not excluded) that renal disease is the cause of the HPN. In our view, this inference is crucial, since it dictates that closer attention must shift to this age group, especially females, in defining primary preventive strategies of renal pathologies.

In conclusion, although we have been unable to compare our findings with those of previous authors, it would seem clear that HPN is not uncommon in the pediatric/adolescent age group of the Saudi population of Gassim. Unlike the findings in the corresponding adults and the impression in earlier studies in other parts of the world, it has been found to have very significantly higher prevalence in females than in males. ISHPN, just as in adults, constitutes the bulk—over half—of the hypertensive population and may have some prognostic implication for nephron damage.

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