Urol Res (1984) 12:1–5

Urological Research

Invited Review

Epidemiology and Socioeconomic Aspects of Urolithiasis

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Summary. This epidemiologic study reveals that the occurrence of urolithiasis in the nineteenth century population in Europe is quite similar to that of the twentieth century in Asia. The analogy is demonstrated for age distribution, stone localization, male/female ratio, and stone composition. The distribution of urolithiasis in a low socioeconomic level population is defined by: highest frequency in childhood, more than 40% bladder stones, less than 20% female patients, less than 40% calcium-oxalate stones, and more than 30% uric acid/urate stones. Typical for a population with a high level these characteristics of urolithiasis are: highest frequency among adults, less than 10% bladder stones, more than 25% female patients, more than 60% calcium oxalate stones, and less than 20% uric acid/urate stones. In partially developed countries those values fall in between.

Key words: Urolithiasis, Epidemiology, Age-sex-distribution, Stone composition, Stone localization.

Introduction

There are many papers about the distribution of urolithiasis concerning age, sex, stone localization, and stone composition. The distribution figures vary over a large range. Even though the discordance vanishes when a high number of reports is checked, one also does not get a single average value. The assumption for any kind of a mathematical mean is not fulfilled, namely, the distinct concentration of single values on a center. All figures for the abovementioned distribution of urolithiasis show two different patterns that are related to the socioeconomic level in developing and industrialized countries.

Method

The following statements are based on a review of the literature – roughly 250 quotations from 54 countries concerning 340,000 urinary stones. References are only cited for papers of outstanding importance (complete list of references available from the author on request).

Results

Age Distribution

Figure 1 shows the frequency of urinary stone formation per year by percentage of all stones for Europe around 1800 [6], for Asia in the twentieth century, and also for Europe in the twentieth century (the term "Europe 20th century" includes the United States and Japan).

The analogy between the two upper curves is striking. Thus the question arises: what are the similarities of living conditions between nineteenth century Europe and twentieth century Asia? When one of these two curves is compared with the age distribution curve for Europe in the twentieth century in the lower part of Fig. 1, it is evident that the age distribution changes from a maximum incidence of 4 years to a maximum of about 40 years. Now the question can be reversed: what are the essential differences in living conditions between Asia and Europe in the twentieth century? The fact that children of Turkish origin in Germany suffer twice as much from urolithiasis as German children shows that the geophysical factor alone cannot be considered the only reason for urolithiasis [4]. Six studies recently published in Afghanistan, India, Pakistan, and Thailand indicate that there is a change in age distribution there. The present age-time curves have two maxima, one for children and one for adults. The change towards the characteristics of industrialized countries is evident.

Percentage of Bladder Stones

In the literature of the nineteenth century pertaining to urolithiasis in Europe, only bladder stones are mentioned.

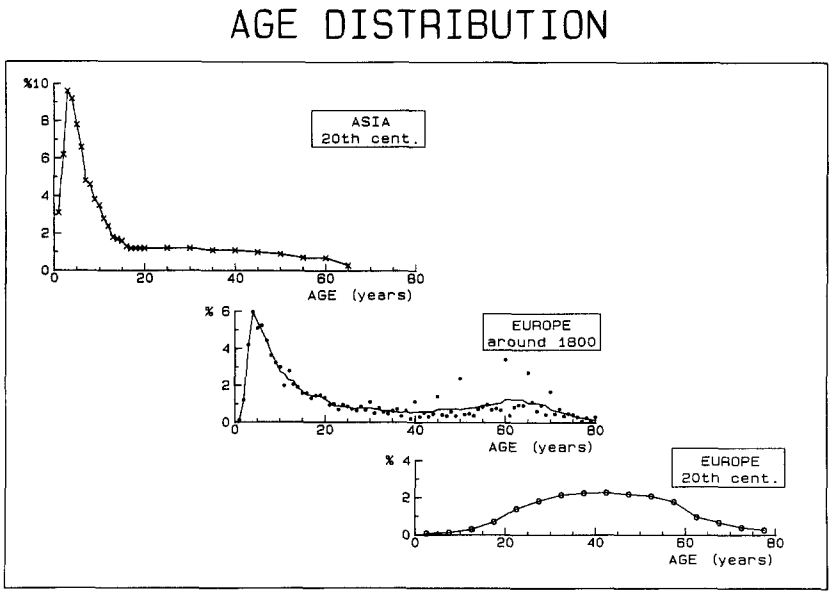

Fig. 1. Age distribution of the annual incidence of urolithiasis in different cultural groups

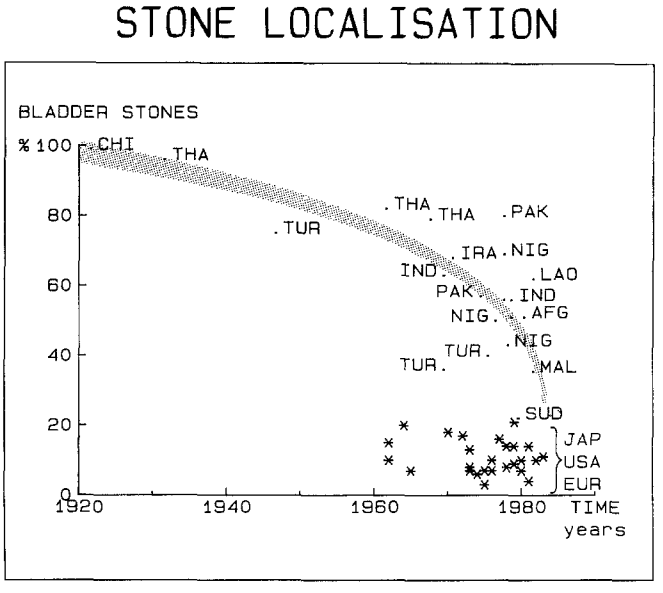

Fig. 2. Share of bladder stones versus year in developing countries (.) and industrialized countries (x) (*Afg*hanistan, *Chi*na, *Eur*ope, *Jap*an, *Ind*ia, *Iraq*, *Laos*, *Mal*aysia, *Nig*eria, *Pak*istan, *Sud*an, *Tha*iland, *Tur*key)

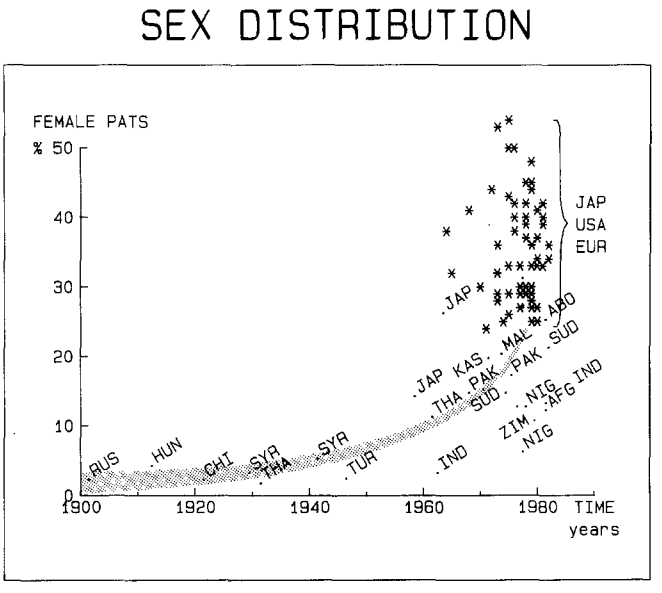

Fig. 3. Share of female patients versus year in developing countries (.) and industrialized countries (x) (*Abo*rigines (Australia), *Afg*hanistan, *Chi*na, *Eur*ope, *Hun*gary, *Jap*an, *Ind*ia, *Kash*mir, *Mal*aysia, Nigeria, *Pak*istan, *Rus*sia, *Sud*an, *Syr*ia, *Tha*iland, *Tur*key, *Zim*babwe)

Kidney stones were not objects to be analyzed and studied because those patients could not get treatment by surgeons. In Fig. 2 the percentage of bladder stones is plotted against the year of publication of the report.

At the beginning of this century the percentage of bladder stones was as high as 90%, e.g., in China and Thailand. Obviously, during the last decades the frequency of bladder stones has been strongly decreasing. Industrialized countries in North America or Europe and Japan have scarcely 10% bladder stones. In Fig. 2 it can also be seen that for Turkey and Thailand, the references dated 20 years later report a smaller share of bladder stones. It is reported from Norwich (England) that the frequency of bladder stones among children decreased between 1875 and 1945 by a factor of 6 [12].

Percentage of Female Patients

The hospital statistics of the last century in Europe quote 5% female patients with urolithiasis. In the eastern part of Europe and in Asia the medical papers in the first half of this century report only 2%–5% female patients. Figure 3 demonstrates the increasing share of female patients during the last three to four decades in developing countries.

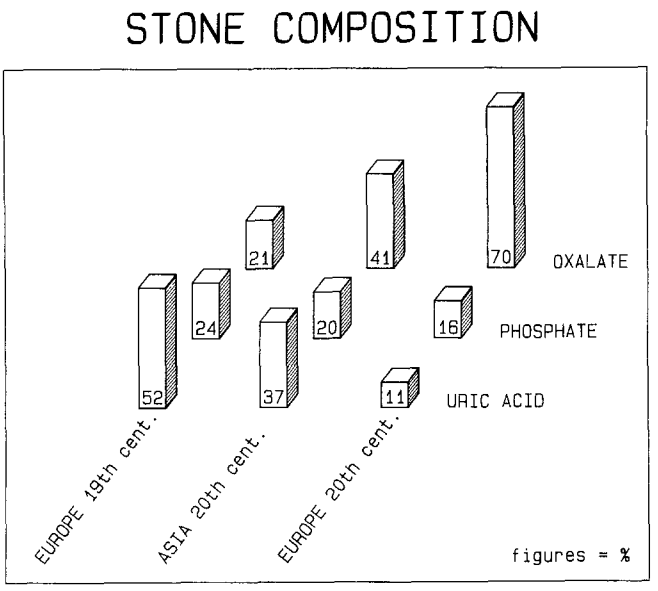

Fig. 4. Stone composition versus cultural group

All countries mentioned twice in this graph show an increase in the percentage of female patients in recent years. That tendency can be seen in Japan, India, Pakistan, Sudan, Syria, and Thailand. In Japan, the share of female patients has even reached a level typical for industrialized countries of >30%.

Interesting figures about the male to female ratio in urolithiasis are reported from Zimbabwe, where the percentage of female patients among the black population is 11% and the caucasian population 25% [9], and from India, where the percentage of female patients among the poor is 14%, and the wealthy 27% [2].

These populations live in the same area and share the same physical environment and the same water supply. These figures suggest that the share of female patients in urological diseases does not depend on the pathophysiological mechanism alone, but on socioeconomical and sociopsychological factors as well.

Stone Composition

All available information about urinary stone composition was grouped in relation to the time and place where the data originated. In Fig. 4 the weighted arithmetic mean per cultural group of the main stone-forming compounds are illustrated (weighted by the number of stones analyzed).

In the row of phosphates, a decrease can be seen in percentage of phosphate stones from the last century in Europe to the twentieth century in Asia and Europe. The phosphates in urinary stones are predominantly apatite and struvite. The differences between these three cultural groups are more evident in the percentage figures of uric acid (urate compounds included). The low figure of 11% for uric acid stones in industrialized countries is artificially reduced by the fact that the statistics on stone composition only include analyzed stones. Nowadays, however, uric acid stones are often dissolved in vivo by medical means, but that, too, is a sign of a high socioeconomic level.

The reduction of uric acid and urate stones accompanying the development from Europe in the nineteenth century to Asia and Europe in the twentieth century is combined with a remarkable increase in the frequency of calcium oxalate stones. Detailed statistics show a similar and significant increase of oxalate stones within relatively short intervals in Japan between 1953 and 1960 [20] and in Great Britain between 1973 and 1981 [13].

The incidence of all urinary stones appears to be increasing [18]. Socioeconomic background may be the reason for this, which can be demonstrated by the fact that in some regions the urolithiasis frequency for caucasians is twice as high as for blacks (U.S. [17] and South Africa [11]). Thus the higher percentage of oxalate calculous does not seem to be the effect of reduction of the other two main compounds of urinary stones alone. Presumably, calcium oxalate stones in industrialized countries are additional stones, to a certain extent at least.

Stone composition data are based on different techniques of urinary stone analysis, with variable reliability. Nevertheless, the tendency is clear: with social development there are less phosphate stones, less uric acid and urate stones, and more oxalate stones.

Socioeconomic Level in the Distribution of Urolithiasis

The distribution of urinary stones is summarized in Table 1. Especially old references from developing countries reveal a strong similarity between the two cultural groups "Europe 19th century" and "Asia 20th century".

However, most modern reports from developing countries concerning age distribution, stone localization, and share of female patients indicate a constant change from values in urolithiasis distribution typical for the last century in Europe towards values observed in all industrialized countries. Thus some partially developed nations show a urolithiasis distribution that is quite different from those at the beginning of this century [19].

The data on the distribution of urolithiasis are more appropriately handled by differentiation between three groups. To separate these groups, each different from the others, as demonstrated in the preceding graphs, arbitrary fixed limits are applied as follows.

The countries with more or less representative data on urolithiasis are classified in Table 2 to obtain the socioeconomic level with regard to urolithiasis. Statistics concerning only urban populations are omitted. In countries with various reports, attention is given to the most recent figures. By averaging the different aspects, the follwing classification results:

High Socioeconomic Level: Austria, Canada, Federal Republic of Germany, Finland, France, German Democratic

Table 1. Urolithiasis in different cultural groups. The figures (n/r/c) indicate the number of stones considered, the number of references consulted and the number of countries the information came from

Distribution of urolithiasis	Cultural groups		
	Europe 19th century	Asia 20th century	USA + Europe 20th century
Age max. y (n/r/c)	4 (5,400/1/20)	4 (41,000/27/20)	40 (12,800/26/21)
Bladder % (n/r/c)		80 → 40 (47,000/16/12)	10 (140,000/19/14)
Female % (n/r/c)	5 (500/2/20)	5 → 25 (6,200/24/20)	35 (140,000/44/21)
Composition % (n/r/c)	(5,100/13/20)	(12,000/25/19)	(178,000/49/21)
oxalate	20	40	70
uric acid/urate	50	35	10
phosphate	25	20	15

Table 2. Discriminating scheme for socio-economic levels

Distribution of urolithiasis		Socioeconomic level		
		Low	Medium	High
Maximum in age distribution	years	4	4+40	40
Share of bladder stones	%	> 40	20–40	< 20
Share of female patients	%	< 20	20–25	> 25
Stone composition:				
calcium-oxalate	%	< 40	40–60	> 60
uric acid + urate	%	> 30	> 20	< 20

Republic, Great Britain, Italy, Japan, Norway, Poland, Portugal, Singapore, Sweden, Switzerland, United States.

Medium Socioeconomic Level: Bulgaria, Czechoslovakia, Greece, Hungary, India, Israel, Yugoslavia, Malaysia, Russia, South Africa, Sudan, Taiwan, Turkey, Venezuela.

Low Socioeconomic Level: Afganistan, Argentina, Brazil, China, Chile, Egypt, Iran, Laos, Mexico, Nigeria, Pakistan, Rumania, Syria, Thailand, Tunisia, Zimbabwe.

If one looks more closely at the data, there are interesting exceptions in the details. For example, in countries in the eastern part of Europe, stone composition looks like a medium level, but the share of female patients corresponds to a high level. The intention of this observation is to demonstrate that not only the overall incidence of urinary stones can help to clarify the pathogenesis of urolithiasis, but that the distribution of urolithiasis may also yield some insight into the stone-forming processes.

Discussion

In conclusion, all data mentioned can be summarized as follows: increasing socioeconomic level is accompanied by the following distribution of urolithiasis:

- decrease in number of children with urolithiasis
- decrease in bladder stones
- decrease in phosphate stones
- decrease in uric acid stones
- increase in female patients
- increase in calcium oxalate stones

The first three can be regarded as the result of a single causal factor in the genesis of urolithiasis: fewer infections because of improved hygiene. This is confirmed by papers published during the last three years: predominance of urogenital infections among children [5, 15], predominance of phosphate and bladder stones among children [10, 14, 23], predominance of gastrointestinal infections with exsiccosis among children with urolithiasis [1, 8], predominance of urolithiasis among children of the poor [4, 10, 15].

The astonishing figures on the share of female patients with stone disease, as well as their differences and changes in time and localization, can hardly be explained by pure pathophysiological causes. It is hypothesized that in populations with a low socioeconomic standard a disproportionately large share of female patients does not obtain the medical advice from a urologist. An example of this is given in the report on Nigeria, where urolithiasis is quite common, but predominantly treated by traditional healers [7].

In industrialized countries there is a remarkable predominance of calcium oxalate stones. A correlation between the increasing number of oxalate stones and increasing food expenditure in affluent societies has been shown [16]. High alcohol ingestion and high protein intake are also under discussion as causal factors [21, 24]. However, that seems to be incompatible with the report from Argentina, where high protein intake is correlated with a high percentage of uric acid stones [3]. Interesting results have been found in several populations. The share of calcium oxalate stones is greater for persons with higher education, e.g., the Federal

Republic of Germany [22], the German Democratic Republic [18] and Austria [25]. Perhaps little physical activity is more typical of intellectuals than high alcohol and protein consumption.

Conclusion

To simplify all these epidemiological data one can conclude:

– Urolithiasis among males and bladder stones among children are predominant in developing countries.

– Urolithiasis with calcium oxalate stones is predominant among adults in affluent societies.

In the early days, it was well observed that there is a higher occurrence of urinary stones in two different populations. In 1820 and 1844, it was observed that urolithiasis often occurs in wealthy men, who tend to eat and drink a lot, and among poor children.

It is tentatively proposed that the occurrence of urolithiasis could be reduced as follows:

– In developing countries, hygienic conditions (water supply) should be improved and urological assistance made available for all.

– In affluent societies, urine volume and substances to be excreted must be kept in balance by increased fluid intake and by moderate nutrition.

Even these trivial measures should prove to be effective.

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