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Relation between Lunch Time and Hourly Output Pattern of *Schistosoma haematobium* Eggs in Urine

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Introduction

The urinary output of *Schistosoma haematobium* eggs is diurnal. Many reports (Bennie, 1949; Stimmel and Scott, 1956; Jordan, 1960; Onori, 1962; Bradley, 1963; Weber *et al.*, 1967; McMahon, 1976; Pugh, 1979) indicate that the peak of egg output occurs in the afternoon, while Shimada (1980) have observed a morining peak. Bell (1969) suggested that the egg output is due to the host's bladder activity rather than to an intrinsic rhythm of the parasite. On the other hand, Dukes and Davidson (1968) and Shimada (1980) reported that the number of excreted eggs was related to urine volume, and Jordan (1962), Weber *et al.* (1967) and Dukes and Davidson (1968) found that strenuous exercise before micturition did not increase the number of eggs. McMahon (1976) suggested that the circadian rhythm of *S. haematobium* egg excretion is related to the body activity of the host. He proposed that these activities, representing physical or chemical stimuli, may trigger the secretion of proteolic enzymes of miracidia, resulting in the extrusion of ova nearest the bladder lumen.

In the present investigation we examined how the timing of the midday meal affects the urinary output of *S. haematobium* eggs by Kenyan children.

Subjects and Methods

The study population consisted of 4 volunteer Kenyan schoolboys (13-15 years old) who were naturally infected with *S. haematobium*. They appeared to be healthy and were quartered in an annex of Kwale Hospital, Kwale, Coast Province, Kenya, for a total of 9 days. At the start of the study, these children excreted more than 1,500 ova per dl urine. During the 9-day observation period, not only their food and water intake but also their activities were controlled. Especially, the excess of water intake more than 200 ml once was avoided even if they felt thirsty. Breakfast was always taken at 7 : 30 - 8 : 00 AM and supper was at 7 : 30-8 : 00 PM. Typically, breakfast was a roll of bread (80 g) and fried egg with a cup of tea (180 ml); lunch, "Chapati" (wheat flower cake, 250 g) and stewed fowl (200 ml); and supper, "Ugari" (maize flower cake, 300 g) and stewed beef (200 ml). The hourly urine output and egg number were recorded from 6 : 00 AM to 9 : 00 AM The children undertook scolastic activities during the days. They usually defecated early in the morning and hourly voluntary urination did not impart any discomfort to the individuals. Hourly urine specimens were passed into special containers given to each subject just prior to the appropriate time. After measuring the osmotic pressure and

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permitting the eggs to sediment (30 min), representative samples (those including less than 200 eggs) were carefully examined under a dissecting microscope, if egg number was very large. Egg counts were corrected for observed hatch miracidia. Data obtained at 6 : 00 AM were taken to represent the over-night urinary volume and egg release.

Results

This study was unintentionally started at school when total urine was hourly collected from 23 schoolchildren (12-16 years old) between 10 : 30 AM and 2 : 30 PM for the initial purpose of collecting many eggs of *S. heamatobium* from urine. By hourly counting the egg numbers, a peak occurred between 0 : 30 and 1 : 30 PM (at that time, almost all skipped their lunch), while the spiky peak occurred between 11 : 30 AM and 0 : 30 PM when they all took lunch at 11 : 30 AM. The average numbers were : with no midday meal, roughly 1,410 ; 2,930 ; 4,740 and 3,520, and with lunch at 11 : 30 AM, 1,330 ; 7,870 ; 1,920 and 2,130 between 10 : 30 - 11 : 30 AM ; 11 : 30 - 12 : 30 AM ; 0 : 30 - 1 : 30 PM and 1 : 30 - 2 : 30 PM, respectively.

No midday meal - Effect on the hourly urine output of eggs

Observations were made on 4 schoolboys for 3 concecutive days. Fig. 1 shows the average percentage for the hourly egg output calculated for 4 individuals over a 3-day period. It demostrates that the peak output mainly occurred between noon and 1 : 00 PM. Variations were noted in 5 sampling periods, one peak took place between 10 : 00 - 11 : 00 AM, three occurred between 11 : 00 AM and noon, and one between 1 : 00 - 2 : 00 PM. Typical variations were seen near the peak : the average percentage (±SD) and the average egg output (±SD) were 13.7±5.6 % and 2,427±1,722 between 11 : 00 AM and noon, 15.8±5.7 % and 2,949±2,373 between noon and 1 : 00 PM, and 10.6±5.0 % and 1,864±1,315 between 1 : 00 - 2 : 00 PM. The average total egg output (±SD) was 17,234±9,024.

Effect of timing of midday meal on the hourly urine output of eggs

For these observations, the 4 subjects were

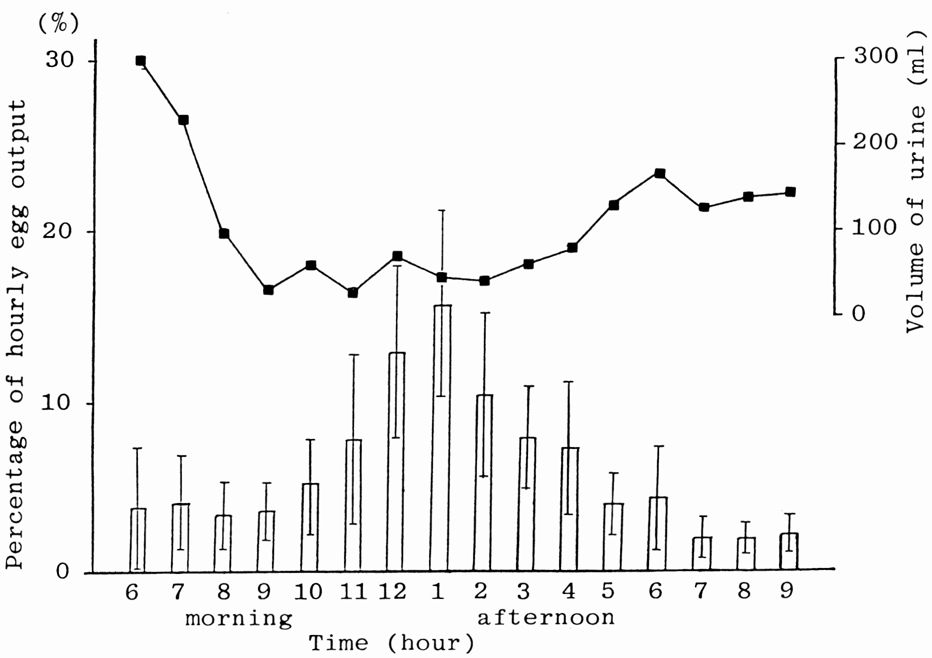

Fig. 1 No midday meal. Hourly urine output of *Schistosoma haematobium* eggs. The values represent the mean±SD. (■—■), urine volume measured at 1-hr intervals.

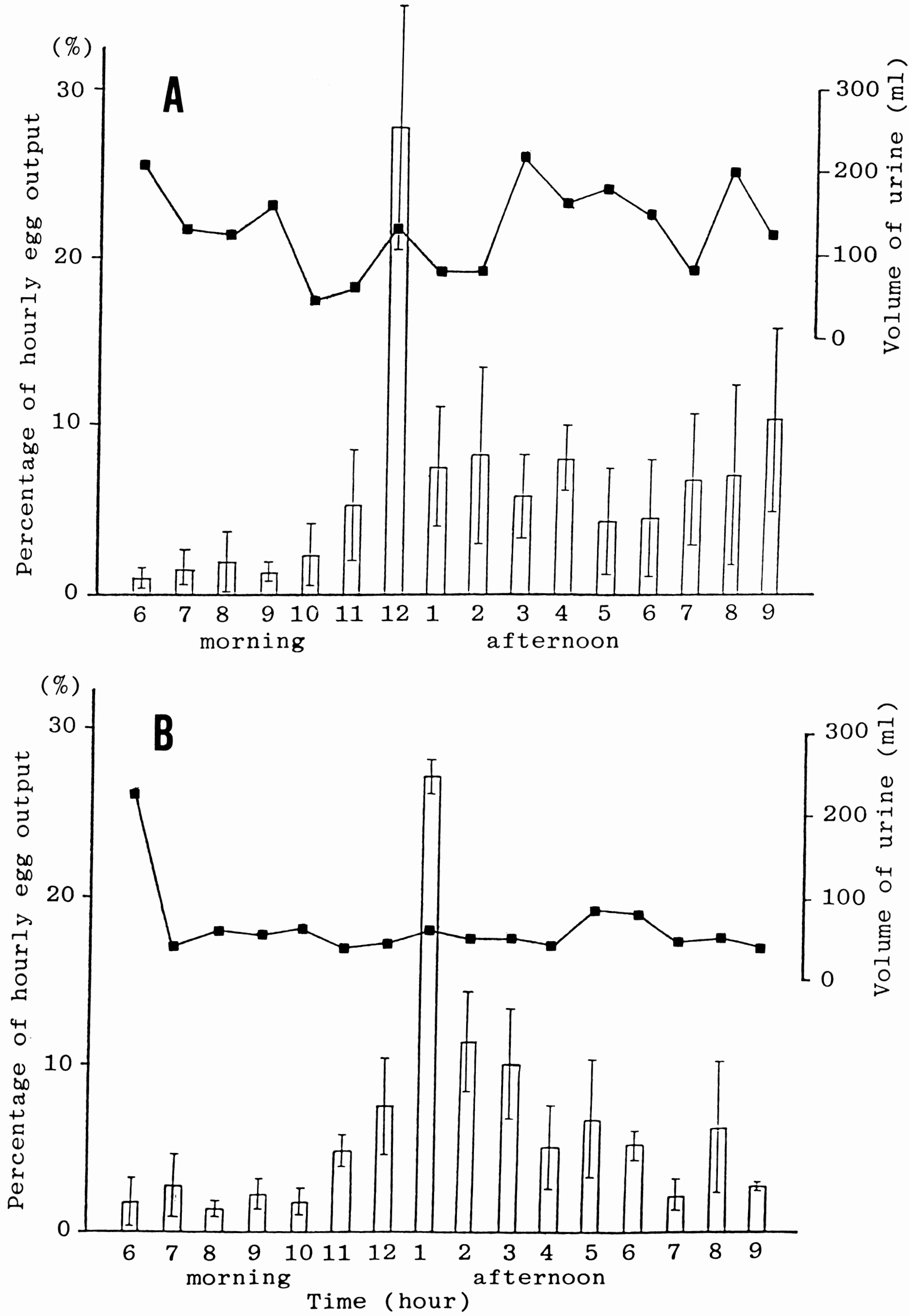

Fig. 2 Early midday meal (A, 10 : 45 - 11 : 00 AM (n=4); B, 11 : 45 - 12 : 00 AM (n=2). Hourly urine output of *Schistosoma haematobium* eggs. The values represent the mean±SD. (■—■), urine volume measured at 1-hr intervals.

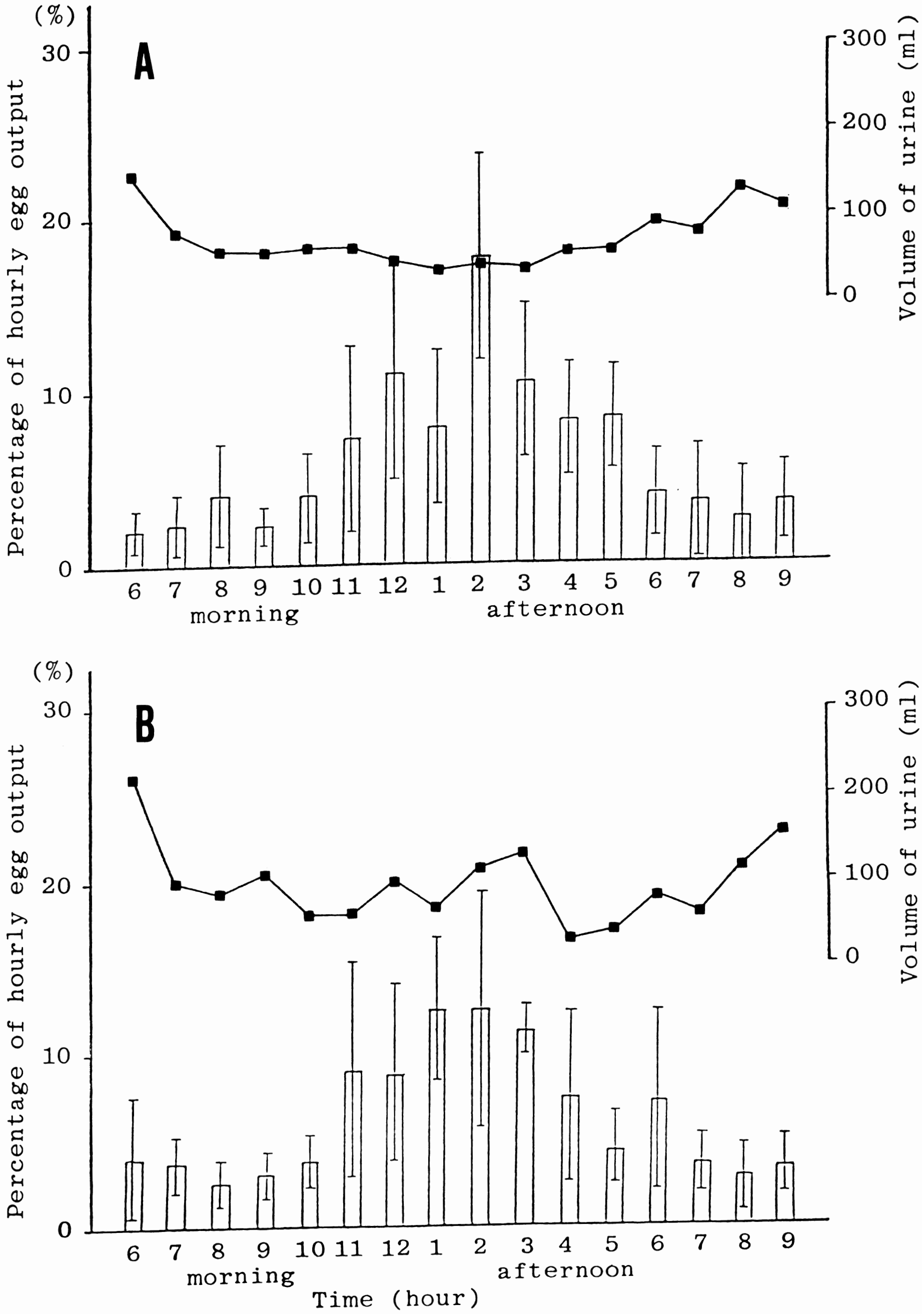

Fig. 3 Late midday meal (A, 0 : 45 - 1 : 00 PM (n=12); B, 1 : 45 - 2 : 00 PM (n=6)). Hourly urine output of *Schistosoma haematobium* eggs. The values represent the mean ±SD. (■—■), urine volume measured at 1-hr intervals.

divided into two equal groups. On day 1, group A ate lunch at 10 : 45 - 11 : 00 AM, group B at 1 : 45 - 2 : 00 PM. On day 2, one member from each group had lunch at 11 : 45-12 : 00 AM, the other member from each group had lunch at 1 : 45 - 2 : 00 PM. On day 3, group A ate lunch at 1 : 45 - 2 : 00 PM, group B at 10 : 45 - 11 : 00 AM. On days 4-6, both groups had lunch at 0 : 45 - 1 : 00 PM.

When lunch was eaten at 10 : 45 - 11 : 00 AM, the egg output peaked between 11 : 00 AM and noon, and when lunch was eaten at 11 : 45 - 12 : 00 AM, the peak occurred between noon and 1 : 00 PM (Fig. 2). Typically, variations were noted near the peak. With lunch at 10 : 45 AM, the average percentage (±SD) and the average egg output (±SD) were 5.3±3.2 % and 1,042±804 between 10 : 00 - 11 : 00 AM, 27.9±7.4 % and 4,516±1,297 between 11 : 00 AM and noon (peak), 7.4±3.5 % and 1,396±880 between noon and 1 : 00 PM. When lunch was taken at 11 : 45 AM, these values were 7.7±4.0 % and 1,325±491 between 11 : 00 AM and noon, 27.5±1.2 % and 5,197±779 between noon and 1 : 00 PM (peak), and 11.8±3.1 % and 2,125±181 between 1 : 00 - 2 : 00 PM. The average total egg output (±SD) per day was 16,527±6,271 when lunch was at 10 : 45 AM and 19,038±3,424 when it was at 11 : 45 AM. In this series, the post-prandial peak egg output always occurred one hour after eating the midday meal.

When lunch was at 0 : 45 - 1 : 00 PM, in 9 of 12 instances, the peak egg output occurred between 1 : 00 - 2 : 00 PM. In one of the remaining 3 cases, the peak was between 10 : 00 - 11 : 00 AM ; in the other 2 cases it was between 11 : 00 AM and noon (Fig. 3A). In all 3 instances in which the peak occurred preprandially, another smaller peak was observed at one hour after eating the midday meal. Typically, variations occurred near the peak ; the average percentage (±SD) and the average egg output (±SD) were 8.0±4.5 % and 1,243±1,050 between noon and 1 : 00 PM, 17.7±6.1 % and 2,737±1,720 between 1 : 00 - 2 : 00 PM (peak), and 10.5±4.4 % and 1,560±961 between 2 : 00 - 3 : 00 PM. The average total egg output (±SD) per day was 12,539±6,982.

When lunch was at 1 : 45 - 2 : 00 PM (Fig. 3B), in only 2 of 6 instances was there a peak output between 2 : 00 - 3 : 00 PM. In the other 4 instances, each peak occurred at 10 : 00 - 10 : 00 AM, noon - 1 : 00 PM (preprandial), 1 : 00 - 2 : 00 PM, or 3 : 00 - 4 : 00 PM. In 2 of these 4 cases a small, post-prandial peak was observed. Typical variations (average percentage (±SD) and average egg output (±SD)) were : 12.5±4.2% and 2,456±1,981 (peak by number) between noon and 1 : 00 PM, 12.6±7.0 (peak by %) and 2,011±983 between 1 : 00 - 2 : 00 PM, 11.3±1.4 % and 2038±997 between 2 : 00 - 3 : 00 PM (post-prandial peak), and 7.4±5.0 % and 1,591±1,488 between 3 : 00 - 4 : 00 PM. The average total egg output (±SD) per day was 17,825±8,675.

Relationship between egg output and volume or osmolarity of hourly urine samples

Figs. 1-3 show the average volumes of hourly urine samples. The water intake during the course of this study was controlled to maintain a relatively constant volume of excreted hourly urine (less than 150 ml). The average total volume of urine excreted per day was 1,760 ml (no meal), 2,258 ml (lunch at 10 : 45 AM), 1,046 ml (lunch at 11 : 45 AM), 1,179 ml (lunch at 0 : 45 PM), and 1,537 ml (lunch at 1 : 45 PM). We observed no correlation between the voided urine volume and the number of eggs secreted in this study.

Discussion

According to previous reports, there are considerable variations in the timing of the peak diurnal output of *S. haematobium* eggs (Bennie, 1949 ; Stimmel and Scott, 1956: Jordan, 1960 : Onori, 1962 ; Bradley, 1963 ; Weber *et al.*, 1967 ; Dukes and Davidson, 1968 ; McMahon, 1976 ; Pugh, 1979 ; Shimada, 1980 ; Doehring *et al.*, 1983). However, in those studies it was not stated how the timing of the midday meal affected the diurnal egg output.

We found that when lunch was taken before noon, the egg output peaked within one hour after the meal. On the other hand, when lunch was after noon, a pre-prandial peak was often followed by another, smaller, peak after the meal. When no midday meal was taken, the peak output occurred between noon and 1 : 00 PM, however, there were individual variations with peaks before noon or after 1 : 00 PM.

Bell (1969) suggested that bladder activity played an important role in egg output and McMahon (1976) stressed the effect of body activity of the host (day-night cycle). Furthermore, there is some controversy on how exercise affects the egg output ; Bennie (1949) reported that it did, while others (Weber *et al.*, 1967 ; Dukes and Davidson, 1968 ; Jordan, 1962) stated that it did not induce an increase in the number of eggs in the urine. In the present study, the activities of all 4 schoolboys were controlled, so that we might avoid variations due to body activity.

Our study population, consisting of 4 infected individuals, is too small to draw any firm conclusions. However, these preliminary observations on 23 infected schoolboys and replicate tests on 4 of them did suggest that the timing of the midday meal affects the diurnal output pattern of *S. haematobium* eggs. Based on these observations, we suggest that after the ingestion of the midday meal, functional congestion of blood occurs in the abdominal organs, including digestive and urinary organs, and that this congestion may promote the extrusion of eggs in the bladder.

In our study, water intake by the individuals was controlled to avoid drinking excess water, and no correlation between the volume of voided urine and the diurnal egg output pattern was seen. This finding coincides with that of Stimmel and Scott (1956) but differs from findings of Dukes and Davidson (1968) and Shimada (1980).

The timing of breakfast and supper did not seem to affect the diurnal output of *S. haematobium* eggs, for which we have no explanation. It is possibe that low-level effects might occur, but be masked by the hourly schedule times. In fact, it is also not clear whether the diurnal egg output follows a circadian rhythm, a suggestion made by Hawking (1975), McMahon (1976) and Doehring *et al.* (1983). McMahon (1976) who took urine samples from patients on 3–11 PM and 11 (PM)–7 AM work shifts, detected a partial shift to a nocturnal pattern.

Further studies are needed to ascertain how the quality and quantity of foods and the other behavioral patterns affect the output of *S. haematobium* eggs, on the mechanism underlying egg excretion and on the circadian nature of egg excretion.

Summary

We studied the hourly urinary output of *Shistosoma haematobium* eggs in four Kenyan schoolboys. If they ate no midday meal, the hourly output peaked between 10 : 00 AM and 2 : 00 PM. If they took an early lunch (10 : 45 or 11 : 45 AM), the egg output peaked within one hour of mealtime. Similar observations were made when lunch was taken late (0 : 45 or 1 : 45 PM), and in some instances a second, smaller peak was noted. Neither breakfast nor supper affected the diurnal output of *S. haematobium* eggs. There was no evidince that the urine volume affected the diurnality of egg output under conditions in which the water intake was controlled.

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ビルハルツ住血吸虫卵の毎時尿中排泄パターンと昼食との関係

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ビルハルツ住血吸虫に感染した四人のケニア人学童(13～15歳)のボランティア協力の下に，尿中への虫卵排泄に及ぼす昼食摂取の影響をみてみると，昼食を摂らない時には虫卵排泄数のピークは学童毎に，又同人でも日毎に出現時刻は異なるが，午前10時から午後2時の間に集中した．全例の算術平均のピークは正午から午後1時にあり，一般的に知られている午後のピークに一致した．一方，学童に昼食を早期(午前10時45分あるいは11時45分)に摂らせると，それぞれの食事後から1時間以内に非常に多量の虫卵排泄をみる“食後のピーク”が出現した．昼食が遅れると(午後12時45分あるいは1時45分)，既に虫卵排泄数のピークがあつたものでは新たに小さな二次ピーク(“食後のピーク”)が現われ，以前にピークが無いと長大な食後のピークが見られた．本観察において学童に過剰な水分摂取を制限させた範囲内で，尿量が虫卵排泄の昼間出現性に関与することは無かつた．