Japan. J. Trop. Med. Hyg., Vol. 17, No. 4, 1989, pp. 285-290 

# INTENSITY, INCIDENCE AND CONVERSION/REVERSION RATIO OF *SCHISTOSOMA HAEMATOBIUM* INFECTION

MASAAKI SHIMADA[1], MIZUKI HIRATA[2], JOHN H. OUMA[3], KATSUYUKI SATO[1], SHINICHI NODA[4] AND YOSHIKI AOKI[1]

Received May 6 1989/Accepted August 25 1989

**Abstract**: The changes in the intensity of *Schistosoma haematobium* infection, incidence and conversion/reversion ratio in a community were observed over a period of 1.5 years. The intensity of infection was judged by two indices: egg counts per 10 m*l* of urine and egg counts per hour. During the study period, 4 urine examinations were conducted at 6-month intervals. Subjects were included in the analysis of the changes in the intensity of infection in a community if they took all 4 urine examinations and were positive for eggs. The changes in the intensity of *S. haematobium* infection differed considerably according to the indices used. The changes in the intensity of infection were compared with the changes in the level of transmission expressed by incidence and conversion/reversion ratio or with the changes in the urine volume. The changes in the intensity of infection expressed by egg counts per hour closely paralleled the changes in both incidence and conversion/reversion ratio in a community, regardless of urine volume. By contrast, when the intensity of infection was expressed by egg counts per 10 m*l* of urine, it did not correlate with the changes in the level of transmission, and was negatively related to the changes in urine volume. These results suggest that egg counts per hour is a reliable index that accurately reflects the changes in the intensity of *S. haematobium* infection in a community.

## INTRODUCTION

Although various indices have been proposed for the measurement of the intensity of *S. haematobium* infection in individual patients (Clarke, 1966; Wilkins, 1977; Stephenson *et al.*, 1984), egg counts per 10 m*l* of urine at midday has been used most frequently thus far. However, one of the shortcomings of this index is that it is affected by daily changes in urine volume, so that the intensity of infection of individual patients varies from day to day.

1 Department of Parasitology, Institute of Tropical Medicine, Nagasaki University, Nagasaki 852, Japan
2 Department of Parasitology, Kurume University School of Medicine, Kurume 830, Japan
3 Division of Vector Borne Diseases, Ministry of Health, Nairobi, Kenya
4 Department of Medical Zoology, Faculty of Medicine, Kagoshima University, Kagoshima 892, Japan

This study was conducted under the Kenya-Japan Communicable Diseases Research and Control Project, with support from the Kenya Medical Research Institute and Japan International Cooperation Agency. The data analysis was carried out at the Nagasaki University Information Processing Center and at the Computer Center, Kyushu University.

Therefore, we recommended the use of an index, that is, egg counts per hour, that is not affected by changes in urine volume. This serves as a stable index for the measurement of the intensity of infection at an individual level (Shimada *et al.*, 1986).

For community-based longitudinal studies, particularly cohort epidemiological studies or control projects, the change in the intensity of infection is a key variable. At a community level, however, the intensity of *S. haematobium* infection has also usually been expressed by mean egg counts per 10 m*l* of urine from infected people. Urine volume varies not only from day to day at an individual level but also from season to season, owing to environmental factors such as temperature and humidity. Therefore, it is highly probable that the mean intensity of *S. haematobium* infection in a community differs from season to season even though there is not a true change in the intensity of infection.

In the present study, we attempted to examine the possible changes in the mean intensity of *S. haematobium* infection in a community judged by two indices, that is, egg counts per 10 m*l* of urine and egg counts per hour, over a period of 1.5 years. The results were then compared with the changes in the level of transmission expressed by incidence and conversion/reversion ratio, and with the changes of the mean urine volume.

## Materials and Methods

The present study was conducted at Mwachinga village, Kwale district, Kenya. The intensity of infection of the patients was expressed by two indices: egg counts per 10 m*l* of urine and egg counts per hour. The details were described elsewhere (Shimada *et al.*, 1986). Briefly speaking, urine was collected 1 hour after the previous urination during midday (11:30-13:30). The volume of each specimen was measured. The nuclepore filter method of Peters *et al.* (1976) was used to filter and count the number of eggs per 10 m*l* of urine, and then the total number of eggs in the urine was calculated. Egg counts per hour was obtained by dividing total egg counts by the time between two urinations.

The intensity of infection in a community was expressed by the mean egg counts of subjects in logarithm. Urine examinations were conducted 4 times during a study period of 1.5 years. The 1st examination was done in May/June 1982, the 2nd in November/December 1982, the 3rd in May/June 1983 and the 4th in November/December 1983. The number of villagers taking each urine examination was 699, 710, 869 and 682 respectively. Among these, 219 completed all urine examinations and were positive for eggs. These 219 patients were subjected to the analysis of the changes in the intensity of infection.

Four urine examinations done during a period of 1.5 years allowed us to calculate the incidence and conversion/reversion ratio in our study area at 6-month intervals. Incidence was expressed as percentage of persons who had been negative at the first survey but were positive for eggs at the second of two surveys. Conversions were the egg positives at a urine examination who had been negative at the preceding examination, while the reversions were the egg negatives at a urine examination who had been positive at the preceding examination.

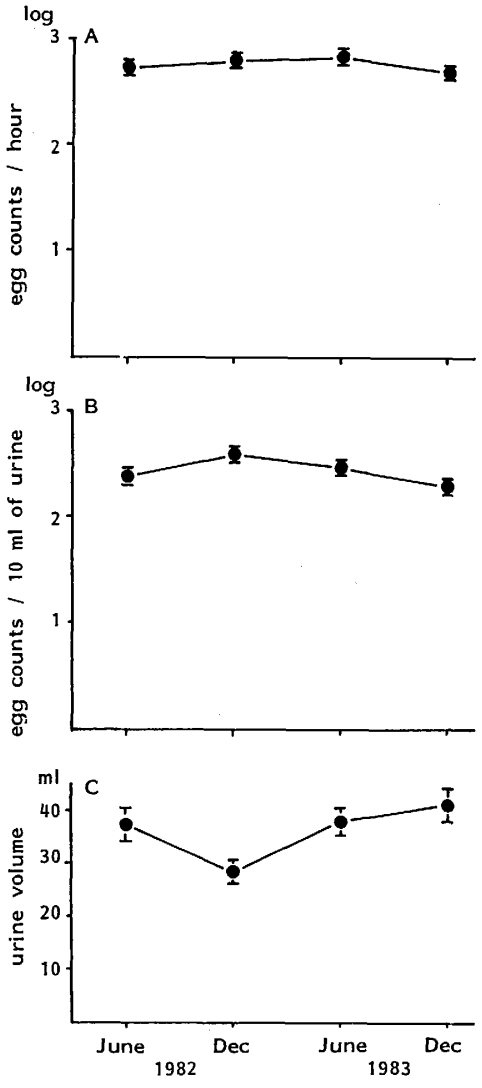


Figure 1 Changes in the intensity of *S. haematobium* infection in a community (A, B) and fluctuation of urine volume (C) over a period of 1.5 years. Intensity of infection was expressed by egg counts per hour (A) and egg counts per 10 m*l* of urine (B).
I represents mean±standard error.

## Results

*Intensity of Infection*

When egg counts per hour was used as an index, the intensity of infection in a community fluctuated slightly (Fig. 1A). The mean log egg counts per hour increased from 2.732 to 2.804 during the first 6-month period between June and December 1982. During the second 6-month period, December 1982-June 1983, the intensity of infection again increased slightly to 2.839. Egg counts then decreased to 2.696 during the third 6-month period. The changes in the intensity of infection over a period of 1.5 years were not statistically significant ($p=0.3674$).

When egg counts per 10 m*l* of urine were used, the pattern of the changes in the intensity of infection was different from that expressed by egg counts per hour (Fig. 1B). Egg counts increased from 2.394 to 2.585 during the first 6-month period, then decreased to 2.474 in the second and to 2.289 in the third 6-month period. The difference in the intensity of infection during the study period was statistically significant ($p=0.0138$). The mean egg counts per 10 m*l* of urine were significantly different between the second and the fourth urine examinations by Scheffe's test ($p<0.05$).

*Incidence and Conversion/Reversion Ratio*

The results are shown in Table 1. Although the incidence was not significantly different from season to season, the incidence among children under 14 years of age during the first and second 6-month periods was approximately 2 times greater than that during the third period.

Conversion/reversion ratios during the first and second 6-month periods exceeded 1, and ratios during the third 6-month period were smaller than 1, but the difference was not statistically significant. The changes of the intensity of infection expressed by egg counts per hour closely paralleled the changes in incidence or conversion/reversion ratio.

*Urine Volume*

The results are shown in Fig. 1C. The mean volume of urine obtained at each examination showed significant changes; 37.51 m*l* for May/June 1982, 28.34 for November/December

Table 1 Incidence and conversion/reversion ratio in the study area

| Study period | Incidence | | Conversion/Reversion ratio | |
|---|---|---|---|---|
| | 0-14 yrs | 15 yrs or more | 0-14 yrs | 15 yrs or more |
| June 1982-Dec. 1982 | 16/73*(21.9)† | 21/81 (25.9) | 16/8‡(2.0)§ | 21/14 (1.5) |
| Dec. 1982-June 1983 | 13/68 (19.1) | 23/75 (30.7) | 13/9 (1.4) | 23/23 (1.0) |
| June 1983-Dec. 1983 | 7/80 (8.8) | 15/70 (21.4) | 7/10 (0.7) | 15/19 (0.8) |

* : No. of egg positives at the second of two surveys who had been negative at the first survey/No. of egg negatives at the first survey

† : (%)

‡ : conversion/reversion: conversion=new infection (− to +), reversion=spontaneously lost infection(+ to −)

§ : ratio

1982, 38.11 for May/June 1983, and 41.23 for November/December for 1983 ($p=0.0097$). The mean volume of urine at the second urine examination was significantly lower than that at the fourth examination (Scheffe's test, $p<0.05$). The fluctuation pattern of the intensity of infection expressed by egg counts per 10 m*l* of urine was mirrored by that of the urine volume.

## Discussion

The data presented in our study show that it is important to reconsider the precision of the indices by which the mean intensity of *S. haematobium* infection in a community has been judged in the past. The changes in the mean intensity of infection in a community during a certain period of time differed considerably according to the index used, that is, egg counts per 10 m*l* of urine or egg counts per hour. When the changes in the intensity of infection were compared with the changes in the level of transmission in our study area, the advantages and disadvantages of the two indices were disclosed.

Incidence and conversion/reversion ratio are considered to indicate the level of transmission in an endemic area of schistosomiasis. When these values are greater during a certain period of time than those during a previous period, the mean intensity of infection in a community is expected to increase during the correnponding period of time, and vice versa. In our study, when the mean intensity of infection was expressed by egg counts per hour, the changes in the intensity of infection in a community during a study period of 1.5 years, although not statistically significant, closely paralleled the changes in incidence and conversion/reversion ratio in that community. By contrast, when it was expressed by egg counts per 10 m*l* of urine, the intensity of infection did not correlate with the changes of the level of transmission.

Variation and stability in *S. haematobium* egg output have long been cosidered (Wilkins and Scott, 1978). In discussions on the changes in egg output, urine volume has usually been indentified as a factor which may affect egg output (Clarke, 1966; Wilkins, 1977; Stephenson *et al.*, 1984). However, there has been no report describing the actual changes in mean urine

volume and their effect on the measurement of the mean intensity of infection in a longitudinal study of a community. Recently, we reported that at an individual level, egg counts per 10 m*l* of urine are affected by the changes of urine volume (Shimada *et al.*, 1984). The present study revealed once more that, at a community level, the changes in the intensity of infection expressed by mean egg count per infection expressed by mean egg count per infection expressed by mean egg count per 10 m*l* of urine were negatively correlated to the changes of mean urine volume ($R=-0.908$, $0.1>p>0.05$, $n=4$). By contrast, the mean egg count per hour was not affected by the changes of mean urine volume.

Although the results of the present and previous studies do not conclusively prove that egg count per hour is the best index for the measurement of the intensity of *S. haematobium* infection, it is undoubtedly a reliable index which can be used as a field technique at both the individual and community levels. Egg count per 10 m*l* of urine measures the concentration of eggs in urine, but not the real intensity of infection.

## Acknowledgments

We express appreciation to Prof. M. Mugambi, Director of Kenya Medical Research Institute; Dr. T.K. Arap Siongok, Director, Division of Communicable Disease Control, Kenya; Dr. J. N. Kaviti, Director, National Public Health Laboratory Services, Kenya; Dr. D. K. Koech, Director, Division of Vector Borne Diseases, Kenya; and Mr. K. Onoda JICA Officer, Nairobi, Kenya, for their encouragement in conducting the present study. We are also grateful to the late Mr. P. Bebora and his staff, and chief of Mwachinga village, for their cooperation during the survey. We wish to express special appreciation to Prof. H. Tanaka, Tokyo University, for his helpful criticism and suggestions in the preparation of the manuscript.

## References

1) Clarke, V. de V. (1966): The influence of acquired resistance in the epidemiology of bilharziasis, Cent. Afr. J. Med., 12, 1-30
2) Peters, P.A., Mahmoud, A.A.F., Warren, K.S., Ouma, J.H. and Arap Siongok, T.K. (1976): Field studies of a rapid, accurate means of quantifying *Schistosoma haematobium* eggs in urine samples, Bull. W.H.O., 54, 159-162
3) Shimada, M., Hirata, M., Sato, K., Wambayi, E., Ouma, J.H. and Aoki, Y. (1986): Egg count in urine to determine the intensity of *Schistosoma haematobium* infection, Japan. J. Trop. Med. Hyg., 14, 267-272
4) Stephenson, L.S., Latham, M.C., Kinoti, S.N. and Oduori, M.L. (1984): Sensitivity and specificity of reagent strips in screening of Kenyan children for *Schistosoma haematobium* infection, Am. J. Trop. Med. Hyg., 33, 862-871
5) Wilkins, H.A. (1977): Variation in urinary creatinine concentration and *Schistosoma haematobium* egg count, Trans. Roy. Soc. Trop. Med. Hyg., 71, 411-415
6) Wilkins, H.A. and Scott, A. (1978): Variation and stability in *Schistosoma haematobium* egg counts: a four-year study of Gambian children, Trans. Roy. Soc. Trop. Med. Hyg., 72, 397-404

# ビルハルツ住血吸虫症の感染の強さ，罹患率と陽転・陰転比

嶋田　雅暁[1]・平田　瑞城[2]・John H. Ouma[3]・佐藤　克之[1]・
野田　伸一[4]・青木　克己

ビルハルツ住血吸虫症の感染の強さ，罹患率，陽転・陰転比の変化を1年半にわたって観察した。感染の強さは2つの指標，尿10 m*l* 中の虫卵数と1時間当たりの排泄虫卵数で表した。調査期間中，6カ月毎に4回尿検査を調査地で行った。すべての調査を受け，かつすべて虫卵陽性であった者を，部落における感染の強さの変化の解析の対象者とした。

感染の強さの変化は，用いる指標によって全く異なった。この変化を罹患率，陽転・陰転比で示した感染の圧力の変化，あるいは尿量の変化と比較した。感染の強さを時間当たりの排泄虫卵数で表すと，その変化は罹患率，陽転・陰転比と同様に変化した。この変化は，尿量の変化とは無関係である。一方，尿10 m*l* 中の虫卵数で表すと，感染の強さの変化は，感染の圧力とは全く関係せず，尿量とは逆相関した。

これらの結果は，調査地でビルハルツ住血吸虫症の感染の強さを表す指標としては，1時間当たりの排泄虫卵数の方が信頼できることを示している。

1　長崎大学熱帯医学研究所寄生虫学部門
2　久留米大学医学部寄生虫学教室
3　Division of Vector Borne Diseases, Ministry of Health, Nairobi, Kenya
4　鹿児島大学医学部医動物学教室