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Influence of Water Availability on Shigella Prevalence in Children of Farm Labor Families

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The marked effect that a sanitary facility may have upon the transmission of diarrheal diseases is strikingly pointed up.

The agriculture of California's San Joaquin Valley is dependent on a large and flexible supply of migrant temporary labor. In the 1952–1953 season at the peak, October, 1952, an estimated 175,000 temporary workers were engaged in agricultural activities in the valley. The number fell to 25,000 in March of 1953. There are shifting, short-time labor needs within the valley, and there is constant change in the composition of the labor force.

Cotton picking is the largest and latest seasonal crop activity in the state and, therefore, is frequently the last job of the year for many workers. Because the valley is climatically and traditionally a favored area for spending the winter and because there is considerable housing available, the migratory workers tend to remain here during their period of unemployment with consequent problems of health, welfare, and education.[1]

The migratory farm labor camps of California's Central Valley (Figure 1) are housing areas owned by growers or community organizations and located on large farms producing seasonal crops. The camps are maintained to house temporary labor during the crop season and rent is usually free. The types of housing and plumbing facilities provided vary from camp to camp. Some camps are composed of permanent dwellings with complete inside plumbing; other camps are made up of temporary one-room structures or tents, or both, with communal faucets, showers, laundry facilities, and pit privies. The quality of the water supplies was tested and found to meet minimum standards in all camps.

During 1950 in Fresno County,[2, 3] the etiology of the diarrheal diseases occurring among several population groups with a high incidence and mortality was studied. The major finding of this survey was that shigellosis constituted an important problem in agricultural labor camp populations and the most important mode of transmission was person-to-person contact. Our concern has been with this particular host-parasite-environmental complex. The 1950 study further suggested that a single environmental factor — water availability — played an important role in determining the prevalence of Shigella infections. Therefore, the main purpose of the 1952–1953 study, here reported, was directed toward more clearly defining the relationship between Shigella prevalence and the availability of water for personal hygiene (laundry, bathing, and especially hand washing). If the relationship proved to be a strong one, increased water availability could be utilized as an efficient control

Table 1—Total Persons and Families Cultured and Per cent Positive for Shigella by Location of Water Faucets in Camps Fresno County, 1952–1953

Location of Water Faucets in Camp	Persons Cultured			Families Cultured		
		Positive			Positive	
	Total	Number	Per cent	Total	Number	Per cent
Total	6,111	296	4.8	2,707	244	9.0
Inside all cabins	428	3	0.7	208	2	1.0
Mixed						
Inside	1,245	34	2.7	569	29	5.0
Outside	3,821	214	5.5	1,702	173	10.2
Outside all cabins	617	45	7.2	228	40	17.5

mechanism over the occurrence of Shigella infections in the labor camp populations.

Survey Methods

The survey methods used in 1952–1953 were essentially the same as in 1950.[2-4] At the initial visit sanitary facilities were recorded, and at every visit and in each camp a complete census was taken. Rectal swabs for the isolation of Shigella and Salmonella organisms were obtained from all available children, 10 years of age and under, usually one-half to two-thirds of all the children in these camps. The swabs were plated on SS agar immediately and then placed in tetrathionate enrichment broth at the camps. These cultures were returned to the field laboratory for screening tests. Cultures resembling Shigella or Salmonella were sent to the Fresno County Health Department Laboratory for further biochemical tests. The final definitive serological typing * was done by the Division of Laboratories, California State Department of Public Health.

There are more than 350 labor camps maintained in the irrigated areas of Fresno County's west side. From these camps 70 were selected for study, primarily on the basis of size. One hundred and fifty-seven visits were made to the camps. The interval between visits in a given camp was at least one month.

Collection of data began in October, 1952, and continued for seven months through April, 1953. During this period, 6,111 cultures were processed and 4.8 per cent (296) found positive for Shigella organisms. Both individuals and families were utilized as the basis for analysis. For this purpose a family was considered as all persons living in one household, and a "positive" family, one in which at least one child was found to be positive for Shigella during

* Shigella alkalescens was identified when found, but has been excluded from all tabulations of Shigella prevalence.

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any month's period. Multiple cultures on any individual at an interval of less than one month were counted as only one culture.

Analysis

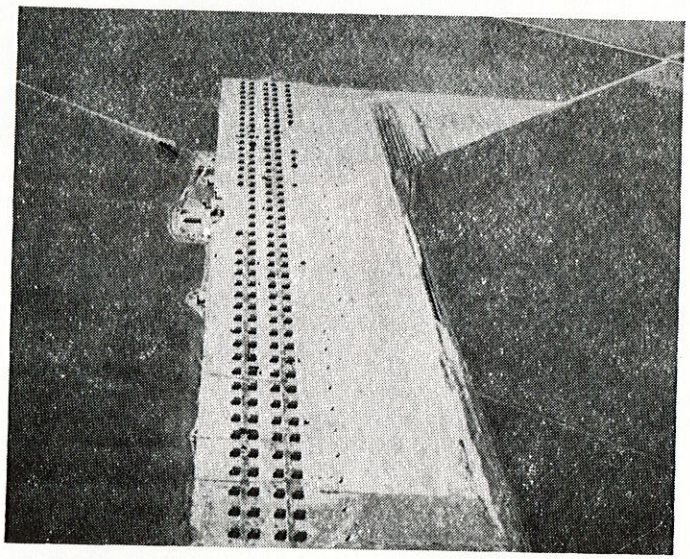
In Table 1 persons and families cultured are classified by the location of water faucets in the camp of residence. The percentage of positive cultures encountered varied widely, low in camps in which all cabins were equipped with private or inside water faucets, high in camps in which no cabins had inside faucets. Camps, where only a portion of the cabins had inside supplies, fell between the two extremes. In such mixed facility camps, the "inside plumbing" portion experienced lower positivity rates than the "outside plumbing" portion. However, the significance of these associations must be interpreted with consideration given to environmental and other factors related to the epidemiology of Shigella infections.

Data for these factors on cabins, classified on the basis of the availability of water, are next analyzed. The statistical grouping of all cabins within a given camp with one type of plumbing has been designated as a "subcamp." The term does not imply physical contiguity for, generally, in the mixed facility camps cabins with inside plumbing were not located together but were scattered.

Three types of "subcamps" were defined as follows: Type 1—cabins equipped with private water faucets, and private showers (tubs) or private toilets, or both; Type 2—cabins equipped with inside water faucets only, other facilities being outside and available for communal use; and Type 3—cabins equipped with no plumbing, all facilities being communal.

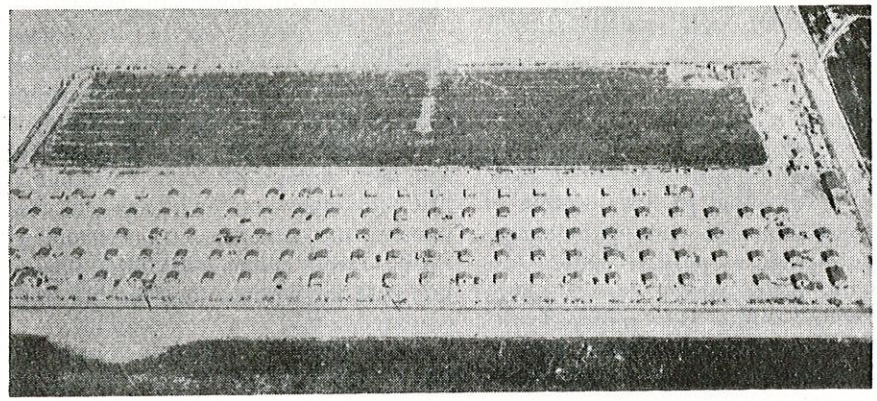
Table 2 also illustrates how Shigella

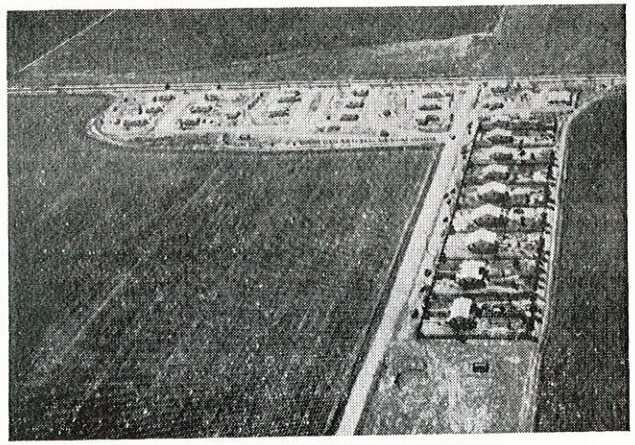
Figure 1—Farm Labor Camps, Fresno County, Calif.



A cotton pickers' camp near Huron, housing over 1,000 persons during the peak season. All cabins are identical one-room structures. A single outside faucet is provided for every eight cabins. Wash houses and showers are located in center of camp. Note row of privies at right.

Figure 1—(Continued)





Note: Isolation of camps from other housing, uniformity of cabins within given camp, and variation in size between camps.

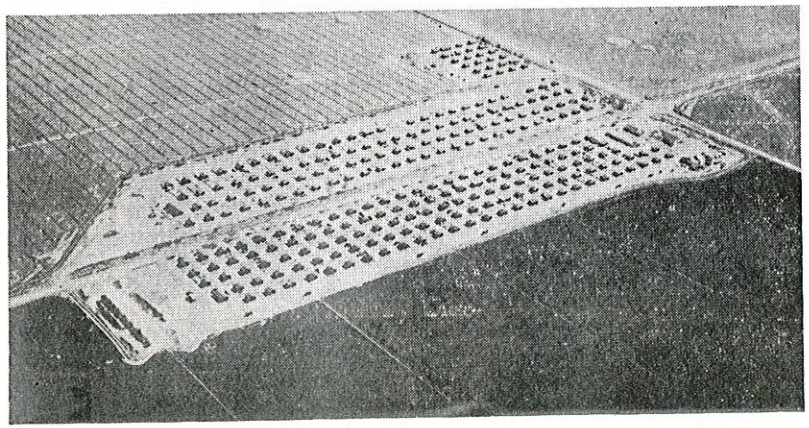


Table 2—Number of Surveys, Cultures, and Families by Type of Subcamp Fresno County, 1952–1953

		Type of Subcamp by Plumbing Inside of Cabin		
		1	2	3
	Total	Faucet and Shower and/or Toilet	Faucet Only	None
Number of subcamps	123	40	35	48
Number of subcamp surveys	279	77	78	124
Number of surveys per subcamp	2.3	1.9	2.2	2.6
Number of cultures obtained	6,111	985	688	4,438
Average number of cultures per survey	21.9	12.8	8.8	35.8
Number of positive cultures	296	16	21	259
Per cent Positive	4.8	1.6	3.0	5.8
Number of families	2,707	472	305	1,930
Number of positive families	244	12	19	213
Per cent Positive	9.0	2.5	6.2	11.0

Source: State of California, Department of Public Health, Special Study Records.

prevalence rates increased markedly as plumbing facilities became more primitive in the subcamps. Rates of 1.6, 3.0, and 5.8 per cent were observed in Types 1, 2, and 3 subcamps, respectively.

The magnitude of the child population was the first factor considered. It is to be noted in Table 2 again, that the Type 3 subcamps provided the greatest proportion of total cultures. This is a reflection of their larger child populations. However, analysis showed that there was an equal chance of finding infected individuals in small and large subcamps of one type. Hence, the higher rates observed in the Type 3 group could not be explained on this basis.

Seasonal patterns were generally the same for each subcamp type (Table 3). The peak occurred in October–November with a drop to a low point in February–March, and an apparent increase in April. The numbers of cultures collected in the three types were fairly proportionate during each season. Hence, differences in prevalence rates could not be accounted for by disproportionate seasonal sampling. Similarly, other factors such as persons per household, persons per toilet, and persons per shower were examined and found not to be significantly associated with Shigella prevalence in this situation.

On the basis of these data from the original 70 camps, the 26 having only a Type 2 and a Type 3 subcamp were selected for further study. A total of 58 surveys had been made in the 26 selected camps, each survey providing a paired observation on both subcamp types. Thus 58 Type 2 subcamp surveys and 58 Type 3 subcamp surveys were made available.

The shower and toilet facilities for each pair of subcamps were communal and used by all occupants of the camp. Housing, flies, garbage, and other environmental factors were comparable for both Types 2 and 3 within a given

Table 3—Total and Positive Shigella Cultures by Type of Subcamp and Season Fresno County, 1952–1953

Season	Type of Subcamp								
	1			2			3		
		Positive			Positive			Positive	
	Total Culture	Number	Per cent	Total Culture	Number	Per cent	Total Culture	Number	Per cent
Total	985	16	1.6	688	21	3.0	4,438	259	5.8
October-November	205	10	4.9	162	7	4.3	1,426	95	6.7
December-January	332	4	1.2	242	10	4.1	1,395	88	6.3
February-March	251	1	0.4	161	1	0.6	1,011	37	3.7
April	197	1	0.5	123	3	2.4	606	39	6.4

Table 3a—Total and Positive Families by Type of Subcamp and Season Fresno County, 1952–1953

Season	Type of Subcamp								
	1			2			3		
		Positive			Positive			Positive	
	Total Families	Number	Per cent	Total Families	Number	Per cent	Total Families	Number	Per cent
Total	472	12	2.5	305	19	6.2	1,930	213	11.0
October-November	103	7	6.8	78	6	7.7	625	81	13.0
December-January	161	3	1.9	99	9	9.1	614	71	11.6
February-March	120	1	0.8	71	1	1.4	416	29	7.0
April	88	1	1.1	57	3	5.3	275	32	11.6

Source: State of California, Department of Public Health, Special Study Records.

camp. Each season is equally represented for both types. In this sense, the seasonal effect can be considered as controlled. Similarly, persons per shower and persons per toilet and other communal environmental factors are matched. This represents proportionate sampling between the two subcamp types according to the extraneous sources of variation.

In Table 4 are listed the average values of six variables for each subcamp type. "Percentage of faucets inside" is based on the total camp populations and, hence, must be the same for both. The average number of persons per household is approximately the same for the

Table 4—Average Values of Six Variables by Matched Subcamps Fresno County, 1952–1953

Variable	Average Value	
	Type 2 (Inside)	Type 3 (Outside)
Per cent total camp population with faucets inside cabins	14.3	14.3
Average number persons per household	6.1	6.0
Persons per faucet	6.1	9.2
Persons per shower	21.8	21.8
Persons per toilet	10.9	10.9
Child population under 11 years	6.9	61.2

Table 5—Summary of Observations on Matched Subcamps Fresno County, 1952–1953

	Type 2	Type 3
Subcamps	26	26
Subcamp surveys	58	58
Cultures	245	2,147
Positive for Shigella	3	127
Per cent positive *	1.2	5.9
Average prevalence rate †	1.1	5.3

* The difference between the two rates is statistically significant with $p < 0.05$.

† The difference between the two rates is statistically significant with $p < 0.001$.

Source: State of California, Department of Public Health, Special Study Records.

two types. In the "inside" group (subcamp Type 2) faucet ratio is determined by persons per household, since each household has a private (inside) faucet. Showers and toilets being communal, the ratios are the same for both "inside" and "outside" groups. The average number of children under 11 years per subcamp is seen to be widely different for the two groups. However, as noted above, there is little indication that positivity rates were affected by the child population size. Typically there were no physical separations between the subcamp types in the 26 selected camps. Cabins with inside faucets were generally scattered in the camp. There is little, if any, segregation between children of families living with either type of plumbing facility.

Table 5 shows the results of the 58 surveys in the 26 camps. One and two-tenths per cent of the cultures taken in households with inside water faucets were positive for Shigella, whereas five times as many (5.9 per cent) of the cultures taken in households with outside water faucets were positive for Shigella. Where an "average prevalence rate" (obtained by averaging 58 rates for each subcamp type) is calculated, the comparison is even more significant, and the probability of as large a difference occurring by chance is less than once in 1,000 (Figure 2—Matched Subcamps).

Discussion

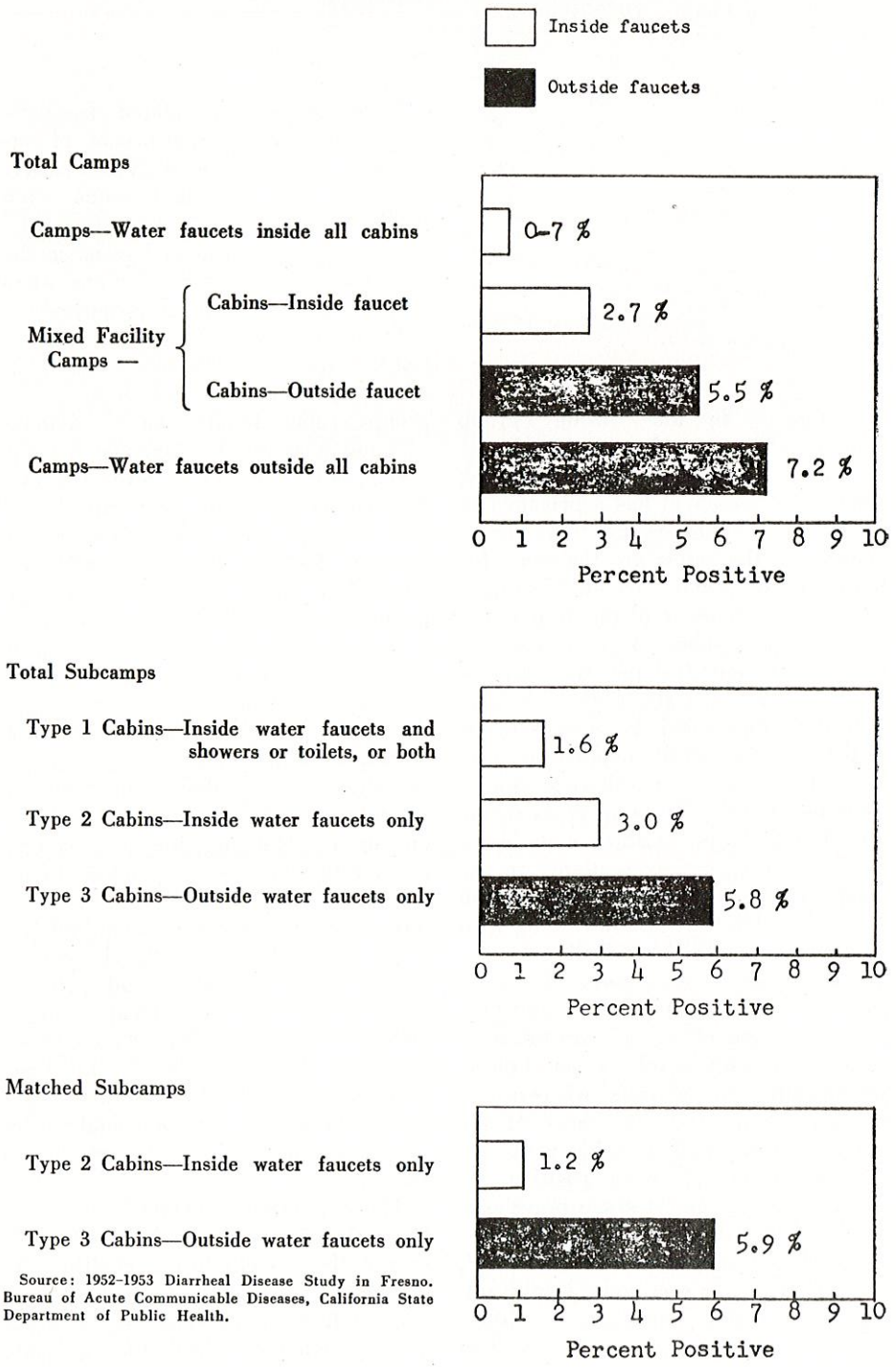
Water has been considered classically as a vehicle for the transmission of certain pathogens to man. Watt first clearly expressed the idea that water, even though it might be "below standard," could act as a diluent and assist in the reduction of intestinal infections when used for personal hygiene purposes.[5]

Data from the 1950 Fresno County, Calif., diarrheal disease studies in migratory farm labor and "fringe" area groups crudely implied that the amount of water available for personal hygiene may have influenced the prevalence rates for the specific pathogen, Shigella.[2, 3] This concept was then examined by Stewart, McCabe, Hemphill, and DeCapito[6] in a fixed rural and semirural population in southern Georgia. They also found that infection rates were highest where water was least available for personal hygiene. Concurrently with the work in Georgia, the study just described was carried out in Fresno County, Calif., to define more clearly the suggested effect of water availability on the prevalence of Shigella infections in migratory labor camp populations.

The California and Georgia studies on this concept represent organized attempts to isolate some of the elements of environmental sanitation and personal hygiene, and begin to evaluate them in order of preventive importance for a particular disease entity—in this case, shigellosis. Only by defining such fundamentals can environmental health programs be brought to maximum efficiency.

The hypothesis, however, remains to be critically tested in the field. We submit that herein lies a challenge to our colleagues in housing, sanitation, and sanitary engineering. Given a human community divided into two com-

Figure 2—Shigella Positivity Rates by Water Availability



Source: 1952-1953 Diarrheal Disease Study in Fresno. Bureau of Acute Communicable Diseases, California State Department of Public Health.

parable groups, into one of which known additional amounts of water for personal hygiene are made easily available, what is the effect of the increased water on the Shigella experience of that population group? Such a field experiment, if successful, could also set the limits of application for this hypothesis. It may be desirable to locate the field studies in several situations in various parts of the world and to expand their scope beyond shigellosis alone. Surely here are speculations to stimulate all disciplines of public health.

Summary

A study of shigellosis in migratory labor camps in Fresno in 1950 suggested that water as a diluent might reduce the prevalence of shigellosis. The present study has shown that Shigella prevalence was associated with availability of water for personal hygiene. Other measured environmental variables did not account for the differences seen. This observation has been independently confirmed by similar findings in a fixed rural and semirural population in southern Georgia.

The finding implies that control of Shigella infections may be significantly improved through a single practical modification of the environment—provision of easily accessible water for personal hygiene. Proof of causative association requires critical, quantitative determination of the effect, if any, of a known increase in water availability for personal hygiene upon a suitable population's experience with Shigella organisms.

It is suggested that workers in the environmental sanitation field might well accept this challenge since the potential knowledge to be gained could have wide application in many places around the world.

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