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SHORT REPORT
Serogroup distribution of urogenital *Chlamydia trachomatis* in urban ethnic groups in The Netherlands

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SUMMARY

The prevalence of *Chlamydia trachomatis* varies between ethnic groups in The Netherlands. It is, however, unknown whether this is associated with specific serogroups. The objective of this study was to determine whether serogroup distribution is associated with ethnic origin in the region of The Hague, The Netherlands. Serogroups of 370 microbiologically confirmed *C. trachomatis*-positive samples were analysed. The samples were obtained from 247 women and 123 men between January and October 2008, of self-reported Dutch Caucasian, Dutch Antillean, Surinamese, N. African/Turkish or other descent. We observed a difference in serogroup distribution comparing Dutch Caucasian women to Dutch Antillean women (χ^2 for distribution $P=0{\cdot}035$). Serogroup C was more common in Dutch Antillean women, whereas serogroup B was less common ($P=0{\cdot}03$). This difference was not observed for Dutch Antillean men. The observed difference in distribution of *C. trachomatis* serogroups between ethnic groups is relevant for further transmission studies.

Key words: *Chlamydia*, ethnicity, serogroup, sexually transmitted infections (STIs).

Chlamydia trachomatis is the most prevalent bacterial sexually transmitted infection (STI) in The Netherlands. In 2011, about 12% of the heterosexual visitors of STI clinics were diagnosed with *C. trachomatis* infection [1]. Ethnicity is one of the determinants of *C. trachomatis* prevalence in The Netherlands. The highest prevalence is found in people of Dutch Antillean and Surinamese descent [1, 2].

C. trachomatis can be serologically subdivided into three different serogroups: B, I, and C. Serogroup B

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consists of serovars B/Ba, D/Da, E, L1, L2a and L2; serogroup I consists of serovars G/Ga and F; serogroup C consists of serovars A, C, H, I/Ia, J, K and L3. Longitudinal studies over the past 25 years show stable serogroup distribution over time in The Netherlands [3]. Overall, serogroup B is the most prevalent, followed by serogroups I and C. This is a similar distribution as observed worldwide [4, 5]. In The Netherlands regional differences are observed for major cities compared to the overall national serogroup distribution [3]. Serogroup B has a stable and high prevalence in all cities, but differences are observed in prevalence of serogroups I and C due to different ethnic compositions [3, 4]. Ethnic composition of cities in The Netherlands is diverse and variable, so the observed difference in serogroup distribution between cities may possibly reflect differences in ethnic composition. The objective of this study is to determine whether serogroup distribution is different in ethnic groups in The Hague, a major city in The Netherlands. This study is, to our knowledge, the first of its kind in Europe.

Chlamydia serogroups were determined for urogenital *C. trachomatis*-positive samples (as determined by PACE2 assay, Gen-Probe Inc., USA) obtained from the municipal STI clinic and the Department of Obstetrics and Gynaecology, MCH Westeinde, The Hague. For this analysis we used samples that were stored from January to October 2008. The STI clinic offers free of charge anonymous screening for STI including tests of self-collected urine samples and vaginal swabs or urethral or endocervical swabs if indicated. At the hospital gynaecology department samples are routinely collected from both endocervix and urethra for various clinical reasons, including pregnancy, discharge, menstrual disorders, subfertility and contraception. Sample numbers were linked to anonymized demographic data as described elsewhere [6]. This includes the following parameters: gender, age, self-reported ethnicity and sexual preference. Self-reported ethnicity has been shown to be a highly valid and representative marker of ethnicity in this context [2].

Serogroup and serovar determination, which are still most frequently used in epidemiological studies, was performed with the *C. trachomatis*-DT assay (Labo Biomedical Products BV, The Netherlands) as described elsewhere [7]. In short, DNA was extracted from the positive swabs and urine samples and amplified followed by detection to confirm the results obtained from the PACE2 assay. Further analysis was conducted with the *C. trachomatis*-DT genotyping assay: a reverse hybridization probe line blot with a probe for the cryptic plasmid and a probe for the three serogroups and different serovars. This study was embedded in a study on serovar distribution by anatomical site as published elsewhere [6].

The following ethnic groups were distinguished: Dutch Caucasian, Dutch Antillean, Surinamese, North African/Turkish and other ethnicity. Dutch Antillean descent is defined as anybody who originated from any island of the former Dutch Antilles. North African/Turkish is defined as anybody who originated from North Africa (Morocco, Tunisia, Algeria, etc.) or Turkey. Except for Indonesian ethnicity, these ethnic groups constitute the most prevalent groups in The Hague and reflect the major ethnic groups in The Netherlands (details available at: http://www.cbs.nl/en-GB/menu/themas/bevolking/cijfers/default.htm, the PKF database [8]). Comparison of serogroup distribution between ethnic groups was performed for each ethnicity *vs.* Dutch Caucasian, using 2×3 tables with the χ^2 statistic for distribution analyses. To determine differences between individual serogroups we performed a χ^2 test with Bonferroni correction. All analyses were performed using SPSS v. 13.0 (SPSS Inc., USA).

A total number of 429 samples from 251 women and 178 men were available for analysis. We excluded samples from men who have sex with men (MSM) ($n = 49$), because their sexual behaviour and sexual network is very different from heterosexuals; they generally have more sexual partners and perform different sexual activities. By excluding MSM, we decreased the amount of determinants influencing the results. Additionally, we excluded samples from men ($n = 4$) and women ($n = 6$) for whom information on sexual preference was not available so that the analysis was limited to heterosexual individuals. As such, serogroup determination was performed for 370 samples.

Age and ethnicity were similar between samples obtained at the STI clinic and the gynaecology department and age was similar between different ethnic groups. Mean age of women was 24·4 (S.D. = 6·5) years and mean age of men was 29·9 (S.D. = 10·9) years. Dutch Caucasian (55%) was the most prevalent self-reported ethnicity, followed by Dutch Antillean (11%) and Surinamese (7%).

Serogroup B was the most common *C. trachomatis* serogroup (49·7%), followed by serogroups I (35·6%) and C (14·6%), except for multiple infections; eight

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Table 1. *Serogroup distribution in women and men of different ethnicities, The Hague, The Netherlands, January–October 2008 (n = 362)*

	Serogroup B	Serogroup C	Serogroup I	Total
Women (*n* = 239)	(*n* = 120)	(*n* = 34)	(*n* = 85)	
Dutch Caucasian	71 (56)	17 (14)	38 (30)	126
Dutch Antillean*	10 (37)	9 (33)	8 (30)	27
N. African/Turkish	8 (44)	2 (11)	8 (44)	18
Surinamese	7 (44)	1 (6)	8 (50)	16
Other	15 (52)	3 (10)	11 (38)	29
Unknown	9 (39)	2 (9)	12 (52)	23
Men (*n* = 123)	(*n* = 59)	(*n* = 19)	(*n* = 45)	
Dutch Caucasian	36 (49)	10 (14)	28 (38)	74
Dutch Antillean	5 (36)	3 (21)	6 (43)	14
N. African/Turkish	3 (50)	1 (17)	2 (33)	6
Surinamese	3 (33)	2 (22)	4 (44)	9
Other	3 (50)	1 (17)	2 (33)	6
Unknown	9 (64)	2 (14)	3 (21)	14

Values given are *n* (%).
* Significant differences were observed comparing Dutch Caucasian women and Dutch Antillean women in serogroup distribution ($P = 0{\cdot}035$). Bonferroni correction was applied for the in-group analyses.

women had infection with two different serogroups (five women with serogroups B and C, three women with serogroups B and I) and were excluded from further analysis. There was no difference in serogroup distribution for *C. trachomatis* between samples obtained from endocervix/vagina (89/149; total 228) and urethra/urine (85/89; total 174); this includes 40 with the same type serogroup infection at both sites. Table 1 shows the serogroup distribution according to sex in urogenital samples for different ethnic groups, Table 2 shows the serovar distribution according to sex for different ethnic groups. We observed a difference in serogroup distribution for women of Dutch Antillean descent compared to Dutch Caucasian women ($P = 0{\cdot}035$). Group-specific comparisons showed a significant difference between serogroups B and C ($P = 0{\cdot}03$), and a trend for serogroup C *vs.* serogroup I ($P = 0{\cdot}098$). Comparison of serogroups B and I did not show a significant difference ($P = 0{\cdot}4$). When serogroup data for men and women were combined, no significant differences were observed between ethnic groups. No differences were observed for the individual serovars between ethnic groups (Table 2). There appears to be a difference in the relative number of multiple infections in both women and men of Dutch Antillean origin: three in women (11%) and two in men (14%) whereas there were no multiple genovar infections in any of the men of other ethnicity (Table 2).

In this study *C. trachomatis* serogroup distribution is associated with self-reported ethnicity, in particular for women of Dutch Antillean descent in our setting. No such difference was observed for men. However, this may be explained by the small group size, in particular the small number of men of Dutch Antillean ethnicity. We observed serogroup distributions that are in concordance with previous studies performed in The Netherlands [3]. When we investigated the group as a whole (i.e. men and women combined), we did not find significant differences between the ethnic groups. This may be due to differences in sexual behaviour between these men and women. No differences for individual serovars were observed.

Although it might be theorized that the distribution of ethnicities in the STI and gynaecology clinics does not reflect the population of The Hague, we have found that the ethnic distribution in the STI and gynaecology groups closely resembles the ethnic distribution of the general population of The Hague [8].

The association between ethnicity and serogroup distribution has been described once before [4]. A study performed in the USA observed that serogroup distribution differs between African American, Asian and Hispanic patients compared to American Caucasians. In that study African Americans were less likely to be infected with serogroup I compared to American Caucasians, while serogroup I was slightly more common in Asians than in American Caucasians.

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Table 2. *Serovar distribution in women and men of different ethnicity, The Hague, The Netherlands, January–October 2008 (n = 362)*

	Serogroup B				Serogroup C					Serogroup I		
	B/Ba	D/Da	E	Multiple	H	I/Ia	J	K	Multiple	F	G/Ga	Multiple
Women ($n = 239$)												
Dutch Caucasian	1 (1)	16 (13)	51 (40)	3 (2)	2 (2)	3 (2)	9 (7)	2 (2)	1 (1)	23 (18)	14 (11)	1 (1)
Dutch Antillean	0 (0)	5 (19)	5 (19)	0 (0)	1 (4)	2 (7)	2 (7)	1 (4)	3 (11)	7 (26)	1 (4)	0 (0)
N. African/Turkish	0 (0)	0 (0)	7 (39)	1 (6)	0 (0)	1 (6)	0 (0)	1 (6)	0 (0)	7 (39)	1 (6)	0 (0)
Surinamese	0 (0)	3 (19)	4 (25)	0 (0)	0 (0)	0 (0)	1 (6)	0 (0)	0 (0)	6 (38)	2 (13)	0 (0)
Other	0 (0)	1 (3)	14 (48)	0 (0)	0 (0)	0 (0)	3 (10)	0 (0)	0 (0)	4 (14)	7 (24)	0 (0)
Unknown	1 (4)	3 (13)	5 (22)	0 (0)	0 (0)	0 (0)	1 (4)	0 (0)	1 (4)	9 (39)	3 (13)	0 (0)
Total	2	28	86	4	3	6	16	4	5	56	28	1
Men ($n = 123$)												
Dutch Caucasian	0 (0)	5 (7)	31 (42)	0 (0)	0 (0)	1 (1)	5 (7)	4 (5)	0 (0)	17 (23)	11 (15)	0 (0)
Dutch Antillean	0 (0)	1 (7)	3 (21)	1 (7)	0 (0)	1 (7)	1 (7)	1 (7)	0 (0)	5 (36)	0 (0)	1 (7)
N. African/Turkish	0 (0)	0 (0)	3 (50)	0 (0)	0 (0)	0 (0)	1 (17)	0 (0)	0 (0)	1 (17)	1 (17)	0 (0)
Surinamese	0 (0)	0 (0)	3 (33)	0 (0)	0 (0)	1 (11)	1 (11)	0 (0)	0 (0)	4 (44)	0 (0)	0 (0)
Other	0 (0)	0 (0)	3 (50)	0 (0)	0 (0)	0 (0)	1 (17)	0 (0)	0 (0)	0 (0)	2 (33)	0 (0)
Unknown	0 (0)	1 (7)	8 (57)	0 (0)	0 (0)	0 (0)	1 (7)	1 (7)	0 (0)	1 (7)	2 (14)	0 (0)
Total	0	7	51	1	0	3	10	6	0	28	16	1

Values given are *n* (%).

The higher prevalence of serogroup C in women of Dutch Antillean origin may reflect differences in sexual behaviour and sexual networking, different virulence of the serovar, and/or other susceptibility due to host genetics. First, a recent study from The Netherlands determining sexual risk factors for *C. trachomatis* infection suggests sexual behaviour varies in ethnic groups [9]: the authors showed that people of Dutch Antillean and Surinamese descent more often had multiple partners in the previous 6 months, had younger age at first sex act, were less likely to use a condom, and were less likely to test for STI, but presented more often with symptoms of STI. However, that study does not mention mixing of sexual partners of different ethnicities. Suchland *et al.* [4] hypothesized in their study that mixing of sexual partners between ethnic groups may rarely occur, explaining their observed different serogroup distributions. They also suggest the possibility of core groups in which a few serovars are transmitted frequently within such a population, which is consistent with results from another study [7]. Even though there is evidence suggesting that differences in behaviour, e.g. travelling to their country of origin and having intercourse with a partner there [10], and sexual networking may be of influence on our findings, we cannot draw such conclusions since we lack data on the sexual behaviour and the ethnicity of sex partners in our study.

Second, an important component is virulence of specific serovars which may be quantified through the amount of inclusion-forming units (IFUs) [11]. Eckert and colleagues found that group B serovars induce the highest number of IFUs, and are thus most virulent, and group C serovars the lowest. They observed marked differences in IFU count between American Caucasians, African Americans, and Native Americans when adding race to their analyses. They hypothesized that differences in immunity to specific serovars between ethnic groups may partially be explained by the observed differences in IFU count [11]. This may possibly be a very important factor in transmission and could offer a good explanation for the differences in serogroup distribution observed between ethnic groups in our study. An outbreak of a specific serovar seems unlikely in this context, since we did not find a serovar being more prevalent in group C of Dutch Antillean women.

Finally, host genetics could play a role. It is estimated that host genetics account for about 40% of disease pathogenesis in *C. trachomatis*-induced trachoma [12], and currently, many genes have been identified to play a role in *C. trachomatis* urogenital infection. However, to our knowledge, these genes have not yet been linked to ethnicity. It is not unlikely that a different composition of the human genome between races increases susceptibility to a *C. trachomatis* infection, or, more specifically, even increases susceptibility to particular serovars.

In conclusion, we observed differences in distribution of serogroups between ethnic groups in an STI/gynaecological population in a main city in The Netherlands and discussed three factors that may explain this phenomenon. These results can be used for further *C. trachomatis* transmission studies.

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DECLARATION OF INTEREST

None.

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