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Incidence of herpes zoster, 1997–2002

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SUMMARY

We estimated age-specific herpes zoster (HZ) incidence rates in the Kaiser Permanente Northwest Health Plan (KPNW) during 1997–2002 and tested for secular trends and differences between residents of two states with different varicella vaccine coverage rates. The cumulative proportions of 2-year-olds vaccinated increased from 35% in 1997 to 85% in 2002 in Oregon, and from 25% in 1997 to 82% in 2002 in Washington. Age-specific HZ incidence rates in KPNW during 1997–2002 were compared with published rates in the Harvard Community Health Plan (HCHP) during 1990–1992. The overall HZ incidence rate in KPNW during 1997–2002 (369/100 000 person-years) was slightly higher than HCHP's 1990–1992 rate when adjusted for age differences. For children 0–14 years old, KPNW's rates (182 for females, 123 for males) were more than three times HCHP's rates (54 for females, 39 for males). This increase appears to be associated with increased exposure of children to oral corticosteroids. The percentage of KPNW children exposed to oral corticosteroids increased from 2·2% in 1991 to 3·6% in 2002. Oregon residents had slightly higher steroid exposure rates during 1997–2002 than Washington residents. There were significant increases in HZ incidence rates in Oregon and Washington during 1997–2002 among children aged 10–17 years, associated with increased exposure to oral steroids.

BACKGROUND

Herpes zoster (HZ) is caused by the reactivation of varicella-zoster virus (VZV) [1]. It is a fairly common cause of morbidity, especially among the elderly, with a cumulative lifetime incidence of 10–20% [2]. The incidence of HZ increases dramatically with age. Age-specific HZ incidence rates in Great Britain during 1947–1962 increased from 74/100 000 persons per year in children <10 years of age, to 1010/100 000 persons per year in persons 80–89 years old [3].

Pediatric zoster rarely occurs and is usually not as severe when it develops [4, 5]. The incidence of HZ in persons under 20 years of age in Rochester, Minnesota during 1960–1981 increased from 20/100 000 person-years in children <5 years old, to 63/100 000 person-years in those aged 15–19 years [4]. The overall HZ incidence rate for persons <20 years of age was similar for males (43/100 000) and females (41/100 000). Among children <5 years of age, females had a higher incidence rate (27/100 000) than males (13/100 000), but these rates were based on small numbers (14 females, 7 males).

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There is some suggestion that HZ incidence rates have been increasing. When adjusted to the standard 1970 US White population, the HZ incidence rate in Rochester, Minnesota increased from 112/100 000 person-years during 1945–1949 to 150/100 000 person-years during 1955–1959 [6]. The age-adjusted HZ incidence rate in the Harvard Community Health Plan (HCHP) during 1990–1992 was considerably higher (287/100 000 person-years) [7].

HZ incidence rates in children are expected to have increased during the 1990s in association with increased exposure to corticosteroids which are known to suppress immune function and increase zoster risk [8]. The prevalence of wheezing conditions in young children and increased use of asthma medications, including oral steroids are reported to have increased during the 1990s [9–11].

The age-adjusted HZ incidence rate in female residents of Rochester, Minnesota during 1945–1959 (134) was slightly higher than in males (126). The overall HZ incidence rates in the 1990–1992 HCHP population were similar for males and females: 219 and 211/100 000 person-years respectively.

Varicella disease has declined dramatically since the introduction of varicella vaccine (VV) in the United States in 1995 [12, 13]. A 50% reduction in varicella incidence in Kaiser Permanente Northwest Health Plan (KPNW) members during 1996–1999 was attributed to a 19% increase in the proportion of children vaccinated [14]. The cumulative proportion of KPNW 2-year-olds vaccinated reached 73% in 1999.

There is considerable interest in possible impacts of VV programmes on the incidence of HZ [15]. A decline in VZV transmission resulting from widespread vaccination may affect persons with prior varicella, but is unlikely to affect vaccinated persons whose risk of HZ is lower. The trigger for reactivation is poorly understood but appears to depend on a decline in cell-mediated immunity. Protection against reactivation may be the result of external boosting (contact with infectious cases), internal boosting (reactivation of the latent virus), or other factors.

Changes in HZ epidemiology following vaccine introduction have been modelled under different assumptions [16, 17]. Assuming that external boosting is the sole determinant of immunity, there could be an increase in HZ (range 0–30%) over 5–40 post-vaccine programme years, followed by a decrease as immunized individuals replace those infected with wild-type VZV. Another theory says that VZV reactivates subclinically with resultant boosting of immunity with unknown effect on HZ incidence. Finally, if boosting does not affect the risk of HZ, the disease will decline progressively as the population of vaccinated persons increases [18].

Surveillance is needed to detect any changes in HZ incidence and to evaluate the impact of varicella vaccination programmes. The Massachusetts Department of Public Health and Seattle's Group Health Cooperative (GHC) are conducting population-based varicella and HZ surveillance and monitoring age-specific incidence rates. Massachusetts has monitored incidence through a statewide telephone survey since 1998 [19], while GHC is examining its automated medical records since 1992. To date, no increase in HZ is evident in any age group in either site (CDC, unpublished data, 2001).

Active HZ surveillance conducted during 2000–2001 in Antelope Valley, California found incidence rates of 307/100 000 person-years in children <10 years old, and 138/100 000 person-years for ages 10–19 years [20]. This represents a conservative two-fold increase among children <10 years old in the post-vaccine period. The VV coverage rate in Los Angles County, which includes Antelope Valley, was 69% in 1999 and reached 82% in 2000. In 2001, approximately 60% of children <10 years in Antelope Valley had received VV. Goodman [20] speculates that a poor cell-mediated response, following primary infection in young children, may result in a greater sensitivity to boosting effects from exogenous exposures relative to older age groups.

We describe a population-based investigation of HZ incidence during 1997–2002 in the membership of KPNW, a pre-paid group practice health maintenance organization (HMO) that serves over 470 000 members in the Portland, Oregon, and Vancouver, Washington areas. Varicella vaccination became a requirement in 1998 for registration in primary and middle schools in Oregon. The state of Washington does not have varicella vaccination requirements for school attendance. The inclusion of states with different VV coverage within the same medical care programme provided a natural experiment for investigating relationships between vaccine coverage and HZ incidence.

We compared overall and age/sex-specific HZ incidence rates in KPNW during 1997–2002, with rates in HCHP during 1990–1992, and tested for secular trends in age-specific HZ incidence rates and differences between Oregon and Washington during 1997–2002. We investigated trends in prevalence of steroid

exposure of children and control HZ trend analyses for steroid exposure.

METHODS

The study population consisted of all persons who had some health plan eligibility during 1997–2002. Annual person-years of eligibility were stratified by age, gender, and state of residence [Oregon (OR), Washington (WA)].

Persons with HZ diagnoses during 1997–2002 were ascertained from KPNW outpatient and in-patient medical care databases using ICD9 code 053 (herpes zoster). They were considered incident cases during 1997–2002 if they had no 053 diagnosis code during 1996. The HZ incidence date was defined as the date of the first 053 code during 1997–2002. Annual rates of first HZ incidence per 100 000 person-years were computed for age, gender, and state strata.

A two-sample medical record abstraction design was used to assess the quality of computerized 053 (herpes zoster) ICD9 codes assigned during 1996–1999. We reviewed all cases aged 0–17 years ($n=642$), and a randomly selected stratified sample of 401 patients of all ages. Ninety children were included in the all-age sample, for a total of 953 ($642+401-90$) chart reviews. The all-age sample was stratified by care setting [in-patient, emergency room (ER), outpatient], age, and whether the zoster diagnosis was coded as established or tentative.

Cases were classified by highest level of care: in-patient if at least one in-patient encounter; ER if at least one ER encounter and no in-patient encounters; outpatient if at least one outpatient encounter and no in-patient or ER encounters.

Tentative diagnoses, referred to as Rule-Out diagnoses, were identified by searching a diagnosis-linked text field in KPNW's computerized medical record system that clinicians can use to indicate that a diagnosis is tentative. The text field is searched for the term Rule-Out or a synonym (e.g. versus, possible, doubt, bordering on).

The positive predictive value of HZ codes was defined as the proportion of cases that met the criteria of probable incident HZ. A case was considered probable HZ if herpes zoster was described as the most likely diagnosis at a face-to-face medical care encounter. The following cases were not considered probable HZ: no provider documentation of a HZ diagnosis; a provider diagnosis of zoster but another definite diagnosis given within a month; and only Rule-Out zoster diagnoses.

Relevant clinical information was abstracted to describe the nature of zoster chart documentation. For each encounter with a zoster diagnosis code we abstracted: whether compatible skin lesions were described, whether Acyclovir was prescribed, and whether a VZV culture was done. The proportion of sample charts meeting the probable HZ criteria were summarized by care setting, age, and gender.

The total number of probable HZ cases in the study population was estimated by multiplying the number of HZ occurrences identified in the databases by the estimated proportion meeting the probable HZ criteria. Annual rates of first probable HZ incidents per 100 000 person-years were computed for age, gender, state strata.

We compared KPNW age/sex-specific and age/sex-adjusted incidence rates of probable HZ during 1997–2002 with HCHP age/sex-specific and overall rates during 1990–1992.

Poisson regression was used to test for sex, age, state, and secular effects, and their interaction effects on KPNW incidence rates of probable HZ during 1997–2002.

To account for differences between HCHP's 1990–1992 and KPNW's 1997–2002 incidence rates of possible HZ among children, we examined secular trends in oral steroid exposure of KPNW children during 1987–2002. Annual oral steroid exposure rates were based on at least one dispensing record in the KPNW automated pharmacy database. Logistic regression was used to test for sex, age, and secular effects, and their interactions on annual steroid exposure rates among KPNW children during 1987–2002.

State of residence was readily available only for 1997–2002. Logistic regression was used to test for sex, age, state, and secular effects, and their interactions in annual steroid exposure rates among KPNW children during 1997–2002.

Person-years of eligibility and annual incidence rates of probable HZ among KPNW children exposed and unexposed to oral steroids were computed for 1997–2002. Poisson regression was used to test for sex, age, steroid exposure, state, and secular effects, and their interaction effects on annual incidence rates of probable HZ among KPNW children during 1997–2002.

The monthly cumulative proportion of KPNW children who received VV was defined as the number

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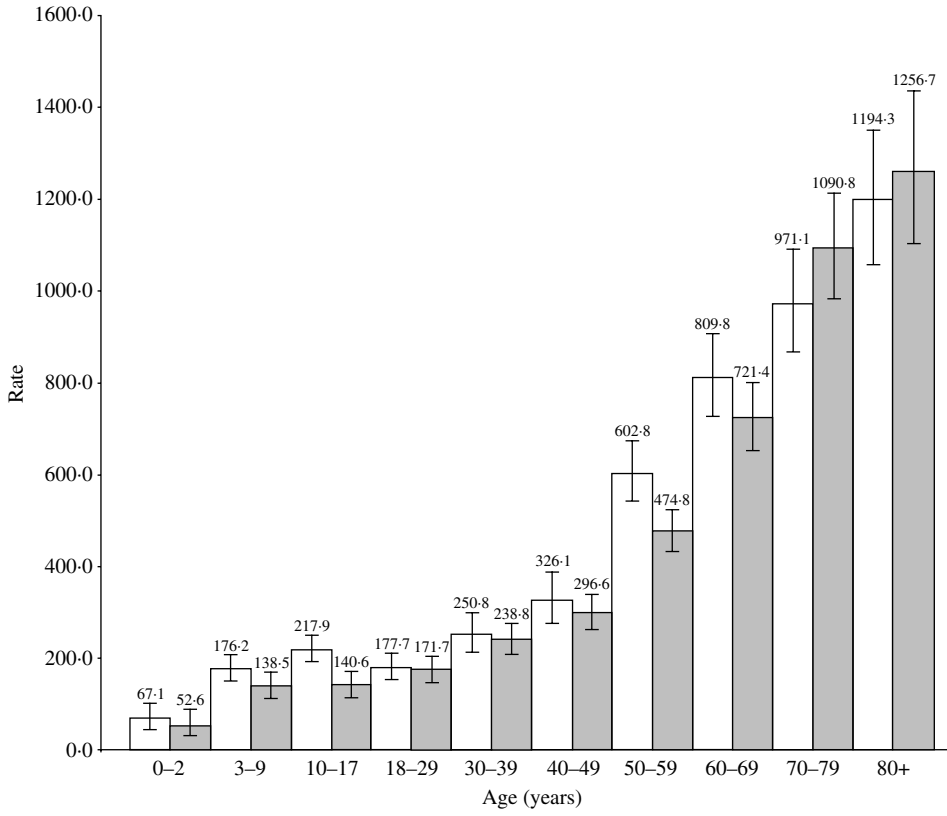

Fig. 1. Herpes zoster incidence rates per 100 000 person-years by age and sex, 1997–2002, Kaiser Permanente Northwest Health Plan (KPNW). ▩, Male; □, female; ⊥, 95% confidence intervals.

of previously vaccinated members divided by the number of members at mid-month. Inclusion in the numerator required health plan eligibility during that month and a record of prior varicella vaccination. Age-specific and overall (age 0–18 years) cumulative proportions of vaccinated members were computed for Oregon and Washington residents.

RESULTS

Rule-Out HZ cases are excluded from the following results. Eighty-four per cent of cases (313/373) with HZ codes met the probable HZ criteria (the most likely diagnosis at a face-to-face medical care encounter). Fifty-one per cent (190) had a provider diagnosis of HZ and a description of compatible skin lesions, 20% (73) had a provider diagnosis of HZ and an Acyclovir prescription, and 13% (49) had only a provider diagnosis of HZ.

Eighty-seven per cent (559/642) of cases aged 0–17 years with HZ codes met the probable HZ criteria. Sixty-two per cent (399) had a provider diagnosis of HZ and a description of compatible skin lesions. Only 5% of cases (33) had a provider diagnosis of HZ and an Acyclovir prescription. Twenty per cent (125) had only a provider diagnosis of HZ.

The proportion of HZ codes meeting the probable HZ criteria [i.e. the positive predictor value (PPV)] varied by medical care setting, age, and gender. Inpatient HZ codes had a higher PPV (94%) than outpatient (including ER) codes (83%). The PPV increased slightly from 82% for age groups 0–17 and 18–49 years to 86% for older patients (50+ years). Children aged 0–2 years had a lower PPV (71%) than older children. The PPV was higher for males (90%) than for females (80%). Males and females had similar PPVs for ages 0–17 years (83%, 82%). Males had a higher PPV than females for ages 18–49 (91%, 76%) and 50+years (91%, 81%). Cases with only Rule-Out HZ codes had only a 35% PPV and were not included in the estimation of incidence rates.

The overall HZ incidence rate during 1997–2002, based on 9895 database diagnoses in 2 269 574 person-years, was 436/100 000 person-years. The estimated incidence rate of probable HZ was 369/100 000 person-years [95% confidence interval (CI), 358–382]. The estimated incidence rate of probable HZ increased sharply with age (Fig. 1). Children <18 years

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Table 1. *Herpes zoster incidence rates per 100 000 person-years (95% CI) for Harvard Community Health Plan (HCHP) members, 1990–1992, and Kaiser Permanente Northwest Health Plan (KPNW) members, 1997–2002*

Age (years)/Sex	HCHP (1990–1992)	KPNW (1997–2002)
0–14 F	54 (34–74)	182 (159–208)
0–14 M	39 (22–56)	123 (102–148)
15–24 F	90 (61–119)	175 (146–208)
15–24 M	121 (80–162)	141 (118–168)
25–34 F	184 (154–214)	230 (191–277)
25–34 M	201 (165–237)	228 (196–263)
35–44 F	194 (156–232)	273 (230–324)
35–44 M	262 (216–308)	263 (231–300)
45–54 F	318 (247–389)	445 (396–500)
45–54 M	307 (235–379)	370 (335–409)
55–64 F	640 (504–776)	689 (618–768)
55–64 M	495 (370–620)	582 (528–642)
65–74 F	876 (650–1102)	939 (837–1052)
65–74 M	1122 (839–1405)	901 (812–999)
75+ F	1629 (1118–2140)	1106 (989–1237)
75+ M	1118 (600–1636)	1218 (1097–1352)
Total	215 (194–240)	370 (358–382)
Standardized		272 (260–284)

accounted for 25·4% of person-time and 10·3% of probable HZ cases. Females had a higher estimated overall incidence rate of probable HZ (396) than males (338) and higher age-specific incidence rates except for ages 70+.

The estimated incidence rate of probable HZ for the KPNW membership during 1997–2002 (369/100 000 person-years, 95% CI 358–382) is 72% higher than the estimate for the HCHP membership during 1990–1992 (215/100 000 person-years, 95% CI 192–240) (Table 1). However, this difference is due to age distribution differences between the two study populations. The KPNW membership contained proportionately more elderly people. Twelve per cent of the KPNW population was 65+ years old, compared with only 3% of the HCHP population. The health plans had similar gender distributions. Males accounted for 54% of person-years in HCHP and for 52% of person-years in KPNW. When KPNW age/sex-specific HZ incidence rates are applied to the HCHP population we obtain a standardized KPNW rate of 272, which is 27% higher than HCHP's rate of 215. However, our incidence rates for the 0–14 years age group (182 for females, 123 for males) were over three times as large as their incidence rates for ages 0–14 years (54 for females, 39 for males).

The cumulative proportion of members vaccinated was higher in Oregon than in Washington (Fig. 2). The cumulative proportion vaccinated increased from 6·6% in December 1996 to 36·7% in December 2002 in Oregon, and from 4·3% in December 1996 to 30·9% in December 2002 in Washington. Among 2-year-olds, the cumulative proportion vaccinated increased from 34·9% in December 1996 to 84·6% in December 2002 in Oregon, and from 24·7% in December 1996 to 82·3% in December 2002 in Washington. The difference between cumulative proportions vaccinated in Oregon and Washington tended to decrease over time.

The prevalence of oral steroid exposure of children (age 0–17 years) tended to increase from 1986 to 2002 (Fig. 3). Boys had consistently higher prevalence rates of oral steroid exposure than girls. The exposure prevalence rate among boys increased from 1·01% in 1986 to 4·02% in 2002, and for girls, from 0·66% in 1986 to 3·08% in 2002.

Comparisons of oral steroid exposure prevalence rates among Oregon and Washington residents were available for 1997–2002. In Oregon, the oral steroid exposure prevalence rate for boys varied from 3·78% in 2000 to 4·81% in 2002 and for girls from 2·74% in 1998 to 3·56% in 2002. In Washington, the equivalent exposure rates for boys varied from 2·98% in 1998 to 3·52% in 2001 and for girls from 2·34% in 2000 to 2·78% in 2002.

Logistic regression analyses found that steroid exposure of children increased significantly from 1987 to 2002 and that the rate of increase diminished over time. Boys had significantly higher exposure rates than girls (OR 1·42, 95% CI 1·40–1·45). The exposure rate was highest for ages 1–2 years and decreased with increasing age group. Infants <1 year had the lowest exposure rate.

Logistic regression analyses of steroid exposure of children during 1997–2002 included state of residence. Oregon residents had greater exposure than Washington residents (OR 1·27, 95% CI 1·23–1·31). There was a significant increasing secular trend in ages 10–17 years (OR 1·02 per year, 95% CI 1·01–1·03) and a significant decreasing trend in ages 0–1 year (OR 0·86 per year, 95% CI 0·82–0·90). The secular trends in the other age groups were not statistically significant.

Oregon and Washington residents had similar increasing trends in overall and age-specific HZ incidence rates during 1997–2002. The overall annual HZ incidence rates in Oregon members during 1997–2002

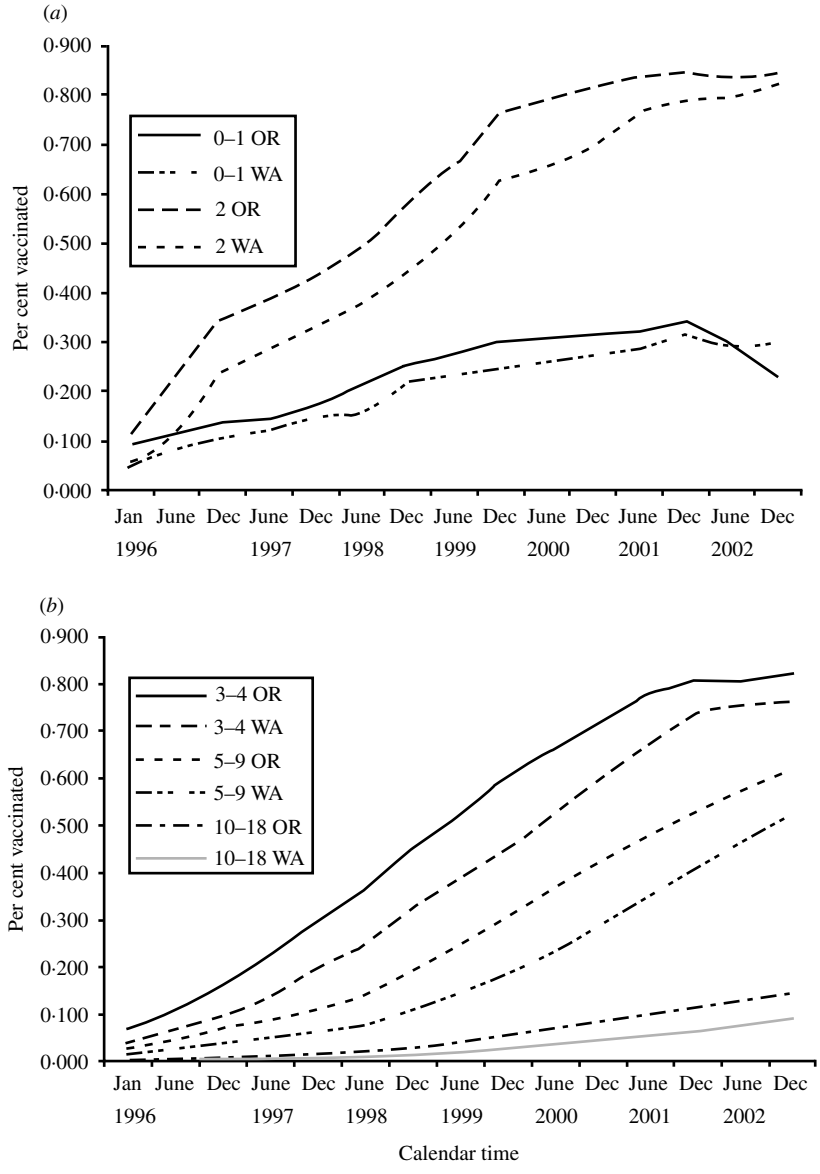

Fig. 2. Cumulative proportion of Oregon (OR) and Washington (WA) members vaccinated by age and calendar year. (*a*) $\leqslant$2 years; (*b*) $\geqslant$3 years.

were 343, 348, 362, 363, 387 and 406, and the corresponding rates in Washington members 329, 351, 357, 367, 393 and 430 (Table 2).

Poisson regression analysis of HZ incidence rates for children and adults during 1997–2002 found a significant overall secular increase (RR 1·03 per calendar year, 95% CI 1·02–1·04) when calendar year, age, sex, age × sex, and state where included in the model. When calendar year × age interaction terms were added to the Poisson model, the significant secular increase was limited to children aged 10–17 years (RR 1·10, 95% CI 1·04–1·17). There was not a significant calendar year × sex interaction effect in the all-ages model. Females aged 3–9, 10–17, 50–59 and 60–69 years had significantly higher HZ incidence rates than their male peers. Oregon and Washington residents had equal rates.

When children were analysed separately, we found a significant overall secular increase (RR 1·05 per calendar year, 95% CI 1·01–1·09) when calendar year, age, sex, age × sex, and state where included in the model. When calendar year × age interaction terms where added to the Poisson model, the significant secular increase was limited to children aged 10–17 years (RR 1·12, 95% CI 1·05–1·18).

When steroid exposure was added to the Poisson regression model for children, it was significant (RR 2·60, 95% CI 1·51–4·47) and the secular increase in

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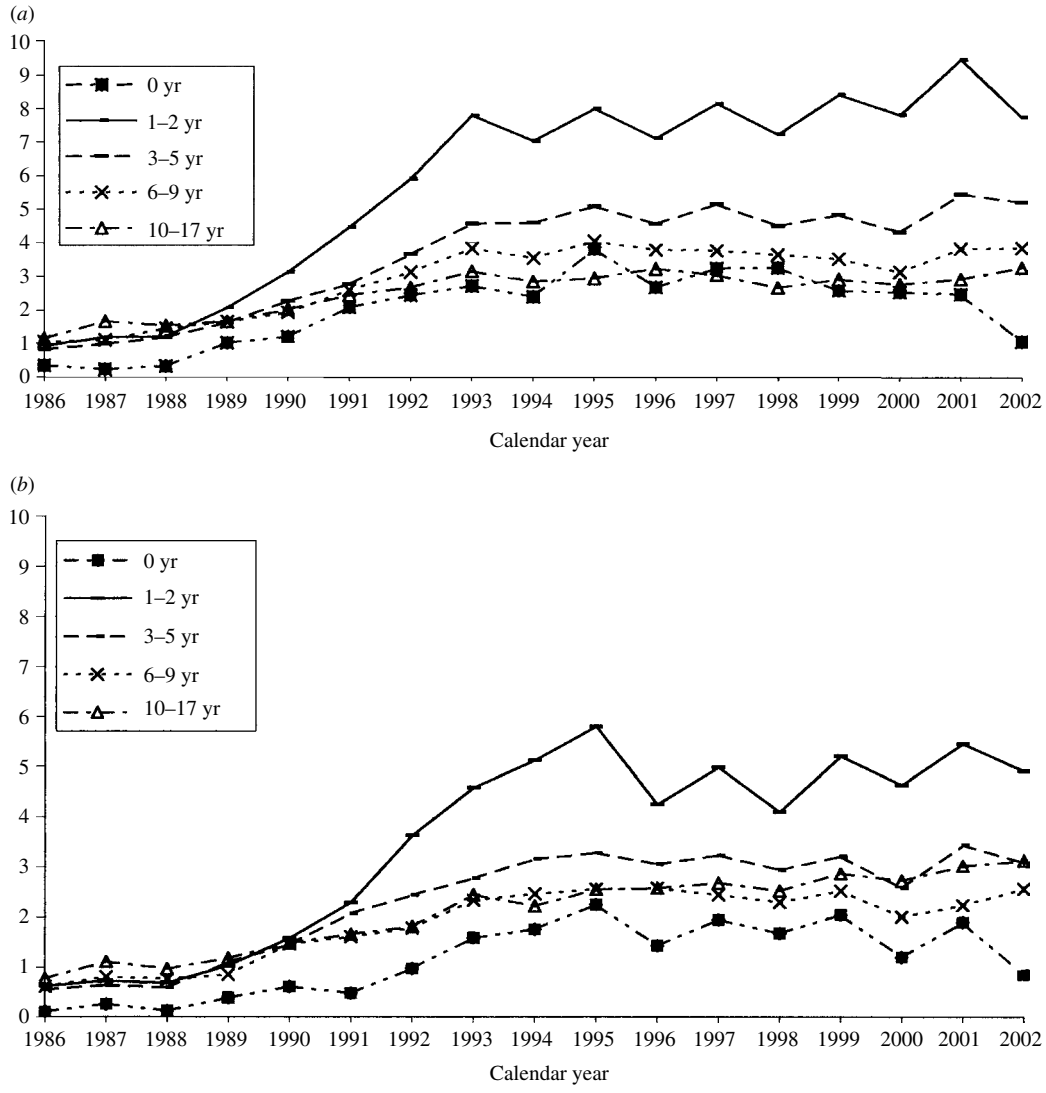

Fig. 3. Prevalence (%) of oral standard exposure by calendar year and age. (*a*) Boys, (*b*) girls.

children aged 10–17 years was no longer significant (RR 1·05 per year, 95% CI 0·91–1·21).

DISCUSSION

Increased HZ incidence in children age 10–17 years during 1997–2002 was probably attributable to increased exposure to oral steroids and not to increased VV coverage.

The secular increases in HZ incidence in children exposed and unexposed to oral steroids were not significantly different, but the secular increase tended to be larger for unexposed children. Hypothesized increases in zoster incidence attributable to reduced opportunities for exogenous boosting of cell-mediated immunity from contact with varicella would be expected to be larger for immunocompetent children since they would be more likely to benefit from contacts with varicella cases.

The observed slight HZ excess in girls is not explained by differences in steroid exposure or vaccine coverage. There were no gender differences in vaccine coverage, and boys had greater exposure to oral steroids, consistent with their greater risk of late–onset and persistent wheezing [10].

Women had insignificantly higher age–specific zoster rates than men in age groups 18–29, 30–39, 40–49 years, and significantly higher rates in age groups 50–59 (RR 1·27) and 60–69 years (RR 1·12). Men had higher rates than women in age groups 70–79 and 80+years but these were not significant. This pattern is generally similar to that seen in general practice in England and Wales [8].

This age pattern of female zoster excess risk may be

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Table 2. *Age-specific herpes zoster incidence rates for Kaiser Permanente Northwest Health Plan (KPNW) residents, 1997–2002*

Age group (years)	1997		1998		1999		2000		2001		2002	
	Rate	S.E.	Rate	S.E.	Rate	S.E.	Rate	S.E.	Rate	S.E.	Rate	S.E.
(*a*) KPNW, Oregon residents, 1997–2002												
0–2	75·5	24·7	29·2	14·8	57·7	21·0	63·4	21·8	36·1	16·4	44·6	18·6
3–9	167·2	24·8	165·0	24·5	169·9	25·0	145·1	23·1	156·2	24·3	155·8	24·2
10–17	136·9	19·2	146·5	19·8	157·0	20·6	184·9	22·3	231·2	25·0	218·0	24·1
18–29	128·4	17·4	143·5	18·1	181·2	20·6	207·3	22·2	159·5	19·0	225·7	23·1
30–39	199·2	22·8	243·7	25·6	229·2	24·8	254·6	26·2	252·1	25·8	301·0	28·4
40–49	326·2	28·8	313·4	28·1	308·1	27·9	294·3	27·0	304·9	27·4	310·4	27·6
50–59	506·2	38·6	491·9	37·0	509·3	37·1	543·5	37·7	578·5	38·1	593·2	37·9
60–69	699·3	59·0	696·7	58·3	799·0	62·1	687·5	56·2	804·9	60·2	790·7	58·2
70–79	1060·5	88·0	1103·9	90·2	999·1	85·4	932·8	82·3	1043·6	87·3	953·9	82·7
80+	1208·1	125·5	1190·4	123·1	1254·0	126·4	1259·4	125·3	1284·1	124·3	1366·6	127·1
Total	342·7	11·4	347·8	11·4	361·8	11·6	362·9	11·6	387·0	11·9	405·8	12·1
(*b*) KPNW, Washington residents, 1997–2002												
0–2	124·9	48·4	101·3	42·3	112·2	43·5	31·3	22·3	21·2	21·3	87·8	44·5
3–9	164·6	37·9	165·1	37·0	125·7	31·5	172·7	37·0	120·8	34·9	132·3	36·8
10–17	131·4	29·5	175·8	33·4	167·1	31·8	193·1	33·9	169·2	34·0	221·0	38·8
18–29	163·0	32·3	172·8	32·6	186·0	33·1	190·5	33·4	165·1	32·2	190·0	34·8
30–39	197·4	35·6	279·5	42·5	216·1	36·5	274·9	41·8	202·3	36·0	284·8	43·3
40–49	312·7	43·6	320·4	43·7	333·3	44·0	316·8	42·6	341·9	44·2	348·3	44·5
50–59	499·7	61·8	516·2	60·6	585·6	62·3	502·9	56·7	606·6	61·1	595·9	59·5
60–69	736·2	96·1	898·1	104·6	604·1	82·7	852·2	98·1	860·9	95·8	940·9	97·3
70–79	956·2	133·2	816·4	121·6	1211·9	148·3	992·3	134·7	1178·1	146·1	1072·0	137·8
80+	974·4	193·3	786·9	169·4	1206·6	207·1	1225·3	207·5	1163·1	196·9	1335·8	205·3
Total	328·9	17·5	351·1	17·8	357·0	17·5	366·6	17·7	393·1	18·9	429·8	19·7

Rates of probable herpes zoster per 100 000 person-years.

partially attributable to gender × age interactions in risks of immunosuppressive conditions and therapies. Such an interaction is seen in US cancer risk statistics for 1996–1998 when the female-to-male ratio of cancer risk decreased from 1·31 for ages 1–39, to 1·14 for ages 40–59, to 0·68 for ages 60–79 years [21].

Our high PPV for in-patient (94%) and outpatient (83%) HZ ICD-9 codes are comparable to those reported by the previous HMO-based study [7]. Adjustment for PPVs of HZ incidence rates based on automated ICD-9 codes is an efficient method for assessing the impacts of varicella vaccination programmes on probable HZ in well-defined health plan populations.

The apparent increase in HZ risk in children during the 1990s associated with increased exposure to systemic steroids requires replication. It is possible that paediatric HZ cases were more likely to be diagnosed in KPNW during 1997–2002 than in HCHP during 1990–1992. However, the observed increase in HZ incidence in KPNW children aged 10–17 years during 1997–2002 is unlikely to be due to changes in diagnostic practices.

We limited our measure of immunosuppression in children to oral steroid therapy because it is the major contributor in children and there has been an increase in wheezing disease in children. We did not have the necessary resources to identify and capture all immunosuppression-associated diagnoses and therapies from KPNW medical care databases.

CONCLUSIONS

A large increase in the HZ incidence rate in children appears to have occurred between 1990–1992 and 1997–2002, based on the application of similar methods at HCHP and KPNW. The overall HZ incidence rate appears to have increased slightly between these study periods.

We found a significant, increasing secular trend in probable HZ during 1997–2002 in KPNW children

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aged 10–17 years that was probably due to increased exposure to oral corticosteroids.

Poisson regression analyses found that children exposed to oral steroids during 1997–2002 had a 2·60 HZ incidence rate ratio (95% CI 1·51–4·47), compared to their unexposed peers. The secular increase in HZ among children exposed to oral steroids was similar to the secular increase in their unexposed peers.

Boys had significantly greater oral steroid exposure than girls. The 1–2 years age group had greater exposure than other age groups. Despite lower steroid exposure prevalence rates, girls had higher HZ incidence rates in KPNW during 1997–2002.

There was a significant secular increase in steroid exposure in children aged 10–17 years during 1997–2002 (OR 1·02 per year, 95% CI 1·01–1·03) and a significant decrease in the 0–1 year group (OR 0·86 per year, 95% CI 0·82–0·90). The secular trends in the other age groups were not statistically significant.

Oregon and Washington residents had similar age/sex-specific HZ incidence rates during 1997–2002. Oregon children had slightly higher age-specific cumulative proportions vaccinated, with state differences diminishing over time. Oregon also had a higher prevalence of oral steroid exposure.

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