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Authors
Cerhan, James R
Kane, Eleanor
Vajdic, Claire M
et al.

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Blood transfusion history and risk of non-Hodgkin lymphoma: an InterLymph pooled analysis

James R. Cerhan[1], **Eleanor Kane**[2], **Claire M. Vajdic**[3], **Martha S. Linet**[4], **Alain Monnereau**[5], **Leslie Bernstein**[6], **Silvia de Sanjose**[7], **Brian C.-H. Chiu**[8], **John J. Spinelli**[9], **Luigino Dal Maso**[10], **Yawei Zhang**[11], **Beth R. Larrabee**[12], **Wendy Cozen**[13], **Alexandra G. Smith**[14], **Jacqueline Clavel**[15], **Diego Serraino**[16], **Tongzhang Zheng**[17], **Elizabeth A. Holly**[18], **Dennis D. Weisenberger**[19], **Susan L. Slager**[12], and **Paige M. Bracci**[18]

[1]Division of Epidemiology, Department of Health Sciences Research, Mayo Clinic, Rochester, MN 55905.

[2]Epidemiology and Cancer Statistics Group, Department of Health Sciences, University of York, Heslington, York YO10 5DD, UK

[3]Centre for Big Data Research in Health, University of New South Wales, AGSM Building, Level 1 (G27), UNSW NSW 2052, Australia.

[4]Division of Cancer Epidemiology and Genetic, National Cancer Institute, 9609 Medical Center Drive Room 7E452, Bethesda, MD 20892-9778.

[5]Registre des hémopathies malignes de la Gironde, Institut Bergonié, University of Bordeaux, Inserm, Team EPICENE, UMR 1219, F-33000; and Epidemiology of childhood and adolescent cancers Group, Inserm, Center of Research in Epidemiology and Statistics Sorbonne Paris Cité (CRESS), Paris, France.

[6]Department of Population Sciences Beckman Research Institute of City of Hope, 1500 E Duarte Rd, Duarte, CA 91010.

[7]Cancer Epidemiology Research Programme | IDIBELL | CIBERESP | Institut Català d'Oncologia.

[8]Department of Public Health Sciences, University of Chicago. 5841 S. Maryland Ave., MC2000, Chicago, IL 60637.

[9]School of Population and Public Health, University of British Columbia, Vancouver, BC, Canada.

[10]Cancer Epidemiology Unit, Centro di Riferimento Oncologico IRCCS, Aviano, Italy.

[11]Section of Surgical Outcomes and Epidemiology, Department of Surgery, Yale School of Medicine, 60 College Street, New Haven, CT 06520.

Corresponding author: James R. Cerhan, MD, PhD, Division of Epidemiology, Department of Health Sciences Research, Mayo Clinic, 200 First Street SW, Rochester, MN 55905. Telephone: (507) 538-0499; Email: cerhan.james@mayo.edu.

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[12]Division of Biomedical Statistics and Informatics, Department of Health Sciences Research, Mayo Clinic, Rochester, MN.

[13]Departments of Preventive Medicine and Pathology, Keck School of Medicine of USC, University of Southern California, Los Angeles, CA.

[14]Epidemiology and Cancer Statistics Group, Department of Health Sciences, University of York, Heslington, York YO10 5DD, UK.

[15]Epidemiology of childhood and adolescent cancers Group, Inserm, Center of Research in Epidemiology and Statistics Sorbonne Paris Cité (CRESS), Paris, France; and Université Paris Descartes, Paris, France.

[16]Cancer Epidemiology Unit, Centro di Riferimento Oncologico IRCCS, Aviano, Italy.

[17]Department of Epidemiology, Brown School of Public Health, Providence, RI 02912.

[18]University of California San Francisco, Dept of Epidemiology and Biostatistics, 3333 California Street, Suite 280, San Francisco, CA 94118.

[19]Department of Pathology, City of Hope Medical Center, 1500 East Duarte Road, Duarte, CA 91010.

Abstract

Purpose.—To conduct a pooled analysis assessing the association of blood transfusion with risk of non-Hodgkin lymphoma (NHL).

Methods.—We used harmonized data from 13 case-control studies (10,805 cases, 14,026 controls) in the InterLymph Consortium. Odds ratios(OR) and 95% confidence intervals(CI) were calculated using unconditional logistic regression, adjusted for study design variables.

Results.—Among non-Hispanic whites (NHW), history of any transfusion was inversely associated with NHL risk for men (OR=0.74; 95%CI 0.65–0.83) but not women (OR=0.92; 95%CI 0.83–1.03), $P_{heterogeneity}$=0.014. Transfusion history was not associated with risk in other racial/ethnic groups. There was no trend with the number of transfusions, time since first transfusion, age at first transfusion, or decade of first transfusion, and further adjustment for socioeconomic status, body mass index, smoking, alcohol use and HCV seropositivity did not alter the results. Associations for NHW men were stronger in hospital-based (OR=0.56; 95%CI 0.45–0.70) but still apparent in population-based (OR=0.84; 95%CI 0.72–0.98) studies.

Conclusions.—In the setting of a literature reporting mainly null and some positive associations, and the lack of a clear methodologic explanation for our inverse association restricted to NHW men, the current body of evidence suggests that there is no association of blood transfusion with risk of NHL.

Keywords

transfusion; lymphoma; etiology; epidemiology; pooled analysis

Introduction

The use of allogeneic blood transfusions increased dramatically after World War II until the 1970s, when concerns about transmitting infectious agents, including Hepatitis B and C and human immunodeficiency virus (HIV) led to a decline in use [1]. Transmission of infectious agents linked to NHL, along with the immunologic impacts of blood transfusions [2], suggest this exposure could be a risk factor for NHL. In a 2010 meta-analysis of 9 case-control and 5 cohort studies [3], blood transfusions were associated with an increased risk of NHL (RR=1.20; 95% CI 1.07–1.35). Results were similar for transfusions given before or after 1992 (a surrogate for increased viral screening and leukodepletion) and by gender. Heterogeneity was observed by study design, with an association observed only in cohort (RR=1.34; 95% CI 1.15–1.55) but not case-control (OR=1.05; 95% CI 0.89–1.25) studies. In a subset of the studies with NHL subtype data, transfusion history was associated with CLL/SLL but not DLBCL or FL. However, the meta-analysis was limited by use of older studies, exposure categories only available from publications, and inability to systematically assess for potential confounding factors or subgroup specific associations. Most importantly there was a lack of systematic assessment of NHL subtypes and limited power to assess NHL subtype-specific associations.

History of blood transfusion was recently evaluated as part of the InterLymph NHL Subtypes Project [4], using individual level harmonized data from 13 case-control studies, of which four US studies [5–8] were included in the prior meta-analysis [3]. In the Subtypes Project, history of blood transfusion before 1990 was inversely associated with risk of NHL overall (OR=0.76; 95% CI 0.67–0.87) but with evidence for heterogeneity by NHL subtype (P=0.013) [9]. In subtype-specific adjusted models, the NHL subtypes showing statistically significant inverse associations were DLBCL (OR=0.69; 95% CI 0.57–0.83) [10], FL (OR=0.78; 95% CI 0.68–0.89) [11], and CLL/SLL (OR=0.69; 95% CI 0.66–0.94) [12]. To better understand these unexpected results, we conducted a more detailed analysis of transfusion history with risk of NHL in the InterLymph Subtypes Project, focusing on population characteristics (race/ethnicity, gender, geographic region, socioeconomic status (SES), prevalence of exposure), study characteristics (population-based vs other; control response rates), and potential confounding factors related to transfusion history.

Materials and Methods

Study population

Participating studies in this pooling project were all members of the InterLymph Consortium (http://www.epi.grants.cancer.gov/InterLymph) that met the following criteria:case-control design with incident cases of NHL diagnosed age 16 years or older; collection of data on transfusion history; and availability of individual level data by December 31, 2011. A total of 13 case-control studies (Table 1) were included [4]. The sites comprising EpiLymph and NCI-SEER were analyzed individually to allow for assessment of center-specific effects and heterogeneity.

Case patients were identified through rapid case ascertainment systems and diagnoses were confirmed using review of pathology reports or diagnostic slides by study pathologists. All

but two studies (NCI-SEER and Italy multicenter studies) had centralized pathology review. As previously reported [4], we grouped cases into NHL subtypes (including cases from the Working Formulation) according to the WHO Classification [13, 14] using guidelines from the InterLymph Pathology Working Group [15, 16].

Controls were frequency matched on age, sex and other design characteristics, and were randomly selected from population registers, random digit dialing, neighborhood matching, or from hospital or clinic patients. With the exception of the Iowa/Minnesota study, which used proxy respondents for deceased cases, all other studies were restricted to living cases. The Yale study enrolled only women and the Iowa/Minnesota study enrolled only men. Most studies excluded individuals with a history of solid organ transplantation or HIV/AIDS; if not, they were excluded from this pooled analysis. All contributing studies were approved by local ethics committees, and all participants provided informed consent.

Risk factor assessment and harmonization

Each study collected risk factor data using a standardized questionnaire that was either selfadministered or interviewer-administered (in-person or by telephone). Each study contributed de-identified, individual-level data for study design variables, NHL subtype, transfusion history, and potential confounding factors including medical history, family history of hematologic malignancy, and lifestyle. Data harmonization was conducted at the InterLymph Data Coordinating Center, as previously described [4].

History of blood transfusion included history of any blood transfusion occurring 1 or more years prior to diagnosis/interview, number of transfusion events, and age and year of first transfusion. Too few studies had indication for blood transfusion or type and quantity of blood/blood product transfused to use in this analysis.

Potential confounding factors available from four or more studies included education/SES, categorized as low, medium and high; family history of any hematologic malignancy in a first degree relative; obesity based on body mass index, and defined as ≤30 versus >30 kg/m^2; cigarette smoking history, defined as never, former or current; alcohol use, defined as never, former or current; history of rheumatoid arthritis; history of hay fever; lifetime recreational sun exposure, defined as quartiles of recreational sun exposure in hours/week; and serum antibodies to hepatitis C virus based on third generation ELISA [17]. Full details on these variables and their harmonization are available elsewhere [4].

Statistical analysis

We used descriptive statistics to estimate the prevalence of transfusion history among controls by age, sex, and race/ethnicity; 95% confidence intervals (CI) were calculated using a normal approximation to the binomial distribution. To compare across studies, we calculated prevalence of transfusion history adjusted for age and sex.

We used odds ratios (ORs) and 95% CI from unconditional logistic regression models to estimate the association of transfusion history with NHL risk. Basic models were adjusted for age, sex and study center. The statistical significance of each association was evaluated by a likelihood ratio test, comparing models with and without the exposure of interest, with

P-values <0.05 identifying potentially significant factors. We first assessed heterogeneity by race/ethnicity and then by sex. We tested for heterogeneity by calculating the Wald statistic for the interaction term between each exposure and stratification variable. We also used meta-analysis and forest plots to further evaluate heterogeneity by study characteristics. To evaluate confounding, we compared basic models with models including additional factors previously suggested as NHL risk factors that were available in at least four of the studies. Finally, for analyses of NHL subtypes, we used polytomous logistic regression. All analyses were conducted using SAS software, version 9.2 (SAS Institute, Inc, Cary NC).

Results

The pooled study population consisted of 10,805 cases and 14,026 controls. Cases compared to controls were well-balanced on sex, age at diagnosis/recruitment, race/ethnicity, and education/SES (Supplementary Table 1). The median age of cases was 60 years (range 18–97) and of controls was 59 years (range 16–97). The most common NHL subtype was diffuse large B-cell lymphoma (DLBCL) (30.2%) followed by follicular lymphoma (FL, 23.5%), while T-cell lymphomas were uncommon (TCL, 5.5%); 0.8% of the cases did not have a subtype classification.

Among controls, the prevalence of ever having had a blood transfusion increased with age and was higher for women (18%) than men (13%) (Supplementary Figure 1). The age and sex adjusted prevalence of transfusion among controls varied from 11.3% to 21.7% across studies (Figure 1). There was no evident correlation between prevalence of transfusion and study region (Figure 1) or hospital versus population-based study design (Supplementary Figure 2). The age and sex adjusted prevalence of transfusion among controls was quite similar across race/ethnicity groups by sex, with perhaps a lower prevalence among Asian women (Supplementary Figure 3).

Transfusion history was inversely associated with risk of NHL for men (OR=0.75; 95% CI 0.67–0.84) but not women (OR=0.94; 95% CI 0.85–1.04), and this difference was statistically significant (*P*=0.014). These associations were largely driven by non-Hispanic whites (Supplementary Table 2 and Supplementary Figure 4), as the other racial/ethnic groups showed highly variable and imprecise associations, mainly driven by small sample sizes. Based on these results, the remaining analyses are restricted to this group and are stratified by sex.

For non-Hispanic white men, the inverse association of transfusion with NHL risk was slightly stronger for one (OR=0.70; 95% CI 0.60–0.81) than for two or more (OR=0.81; 95% CI 0.65–1.00) transfusions compared to no transfusions (Table 2). No dose-response effects were observed for time since first transfusion, age at first transfusion, or decade of first transfusion. For non-Hispanic white women, having had any transfusion was weakly associated with NHL risk (OR=0.92; 95% CI 0.83–1.03), although an inverse association was observed for two or more transfusions (OR=0.76; 95% CI 0.36–0.92) compared to no transfusions. No consistent associations were observed with time since first transfusion, age at first transfusion or decade of first transfusion

The prevalence of transfusion history among controls for selected NHL risk factors among controls is shown in Table 3. Overall, only SES, never smoking (for men), and recreational sun exposure showed greater than 5% difference in prevalence of transfusion history between exposure categories. Adjustment for each of these factors in the basic model did not alter the associations reported in Table 2 (data not shown), nor did simultaneous adjustment for age, gender, study center, SES, BMI, sun exposure, smoking and alcohol (Supplementary Table 3). We had HCV serology on a subset of 1310 cases and 1889 controls, and a positive serology was more common in controls with a transfusion history than those with no history for both men (5.0% vs. 3.2%) and women (6.0% vs. 2.7%). Adjustment for HCV serology attenuated the weak inverse transfusion association towards the null for women (OR=1.02; 95% CI 0.67–1.55) but did not alter the association for men (OR=0.69; 95% CI 0.48–0.99).

Results for the association of transfusion with NHL risk varied by study design. For men, the pooled risk estimates were stronger for hospital-based studies (OR=0.56; 95% CI 0.45–0.70) relative to population-based studies (OR=0.84; 95% CI 0.72–0.98). In contrast, for women, the transfusion and NHL association was nearly identical for hospital-based (OR=0.91; 95% CI 0.75–1.10) and population-based (OR=0.93; 95% CI 0.82–1.06) studies.

We next explored whether results differed by study region (Figure 2). For men, the inverse association was strongest for studies from southern Europe (OR=0.53; 95% CI 0.36–0.79), intermediate for Northern Europe (OR=0.62; 95% CI 0.49–0.79), and weakest but still evident for North America (OR=0.83; 95% CI 0.71–0.98). For women, there was little heterogeneity by study region.

NHL subtype-specific associations with transfusion history by sex are shown in a forest plot (Figure 3). For men, there were statistically significant inverse associations with follicular lymphoma, DLBCL, and CLL/SLL, and ORs were less than 1 for all of the other subtypes except for Mycosis Fungoides/Sezary Syndrome (OR=1.07). For women, a statistically significant inverse association with follicular lymphoma, and suggestive inverse associations with CLL/SLL and PTCL were observed. In contrast, several subtypes showed suggestive elevations in risk with transfusion history, but none of the results were statistically significant.

Discussion

In this pooled analysis of 13 studies, which provided over 10,000 cases and 14,000 controls, which expands on previously published InterLymph results, we found an inverse association of self-reported blood transfusion history with risk of NHL that was confined to non-Hispanic white men, and was specific to follicular lymphoma, DLBCL and CLL/SLL. These results were not confounded by lifestyle factors or HCV seropositivity, nor were they explained by era of first transfusion, geographic region of the study, hospital versus population-based study design, or control response rates.

Strengths of this pooled analysis included the large sample size with studies from multiple geographic regions, systematic evaluation of NHL subtype, harmonized data on transfusion and potential confounders, careful assessment of confounding, and some, albeit limited, data

by race/ethnicity. The major limitations are the potential bias arising from the use of the case-control study design, lack of validation of self-reported transfusion history, limited data on characteristics of the transfusion and no data about the type of blood or indication for transfusion.

The inverse association among men was unexpected, and it is uncertain if the association is due to bias. In the Castillo et al. meta-analysis, risk estimates were similar for men (RR=1.19; 95% CI 1.03–1.38) and women (RR=1.26; 95% CI 1.09–1.45). Era of transfusion overlaps the cohort studies that have reported a positive association. While the case-control studies in the Castillo et al. meta-analysis [3] showed no evidence of an association with transfusion history, this included only four [5–8] of the 13 studies reported here. We were unable to assess confounding by indication, although it is unclear what type of medical indication would generate an inverse association. It is not clear that confounding by other NHL risk factors (or unknown confounders) is an explanation, as we found little evidence for this, and negative confounding would be needed to generate an inverse association. Recall bias is always a concern in case-control studies, but to generate an inverse association, controls would need to systematically over-report (or cases under-report) transfusion history, a situation for which we have no supportive evidence. Finally, selection bias, through differential participation or source of cases and controls might be an explanation, and we did see a stronger inverse association among hospital versus population-based studies, with the hospital-based control group perhaps enriched for prior exposure to blood transfusions. Yet none of these are particularly compelling explanations and our findings could be a false positive result.

As discussed above, the five cohort studies in the Castillo et al. meta-analysis [3] were associated with an increased risk of NHL (RR=1.34; 95% CI 1.15–1.55). Since that publication, a large population-based case-control study nested in the SEER-Medicare cohort (all subjects age 65 years and older) reported that blood transfusion (obtained from linked records) was positively associated with risk of NHL (OR=1.17; 95% CI 1.12–1.23) and was specifically elevated for DLBCL, MZL, CLL, LPL and TCL, but not FL [18]. However, except for LPL and MZL the strongest ORs were observed for the shortest latency (<2 years), suggesting the effect was due to reverse causality, consistent with results of other studies [8, 19, 20]. The SEER-Medicare study also reported stronger ORs for the association of transfusion with NHL risk for transfusions given for GI bleeding and unspecified anemia, relative to surgical procedures, which has been reported in other studies [5, 6]. This raises concerns of either reverse causality (lymphoma causing anemia) or confounding by indication of medical conditions associated with both risk of transfusion and NHL. In the Million Women Study [21], history of blood transfusion after 2000 (modern era of intense viral screening) was ascertained from electronic hospital records. In that study, there was also an elevated risk of NHL <5 years after transfusion (RR=4.69; 95% CI 3.79–5.82). Interestingly, risk was also elevated more than 5 years subsequent to transfusion (RR=2.63; 95% CI 1.45–4.78) and only slightly attenuated following adjustment for smoking, alcohol use, and body mass index. Finally, in a Scandinavian study that linked population, blood bank and health care registers, there was no evidence that blood transfusions from donors who later developed cancer were associated with risk of lymphoma [22] or that transfusion

recipients' risk of CLL was affected by post-donation CLL in the donor (i.e., that the donor presumably had the precursor monoclonal B-cell lymphocytosis at time of donation) [23].

In summary, in a large, pooled analysis of 13 case-control studies we observed an unexpected inverse association of transfusion history with NHL risk, but restricted to the subgroup of non-Hispanic white men and lacking any dose-response. In the setting of a literature reporting mainly null or positive associations, and the lack of a clear methodologic explanation for our results, the current body of evidence provides little support for a causal association of transfusion history with risk of NHL.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Abbreviations

BMI	Body mass Index
DLBCL	Diffuse large B-cell lymphoma
FL	Follicular lymphoma
HIV	Human immunodeficiency virus
NHL	Non-Hodgkin lymphoma

NHW	Non-Hispanic whites
SES	Socioeconomic status
TCL	T-cell lymphoma

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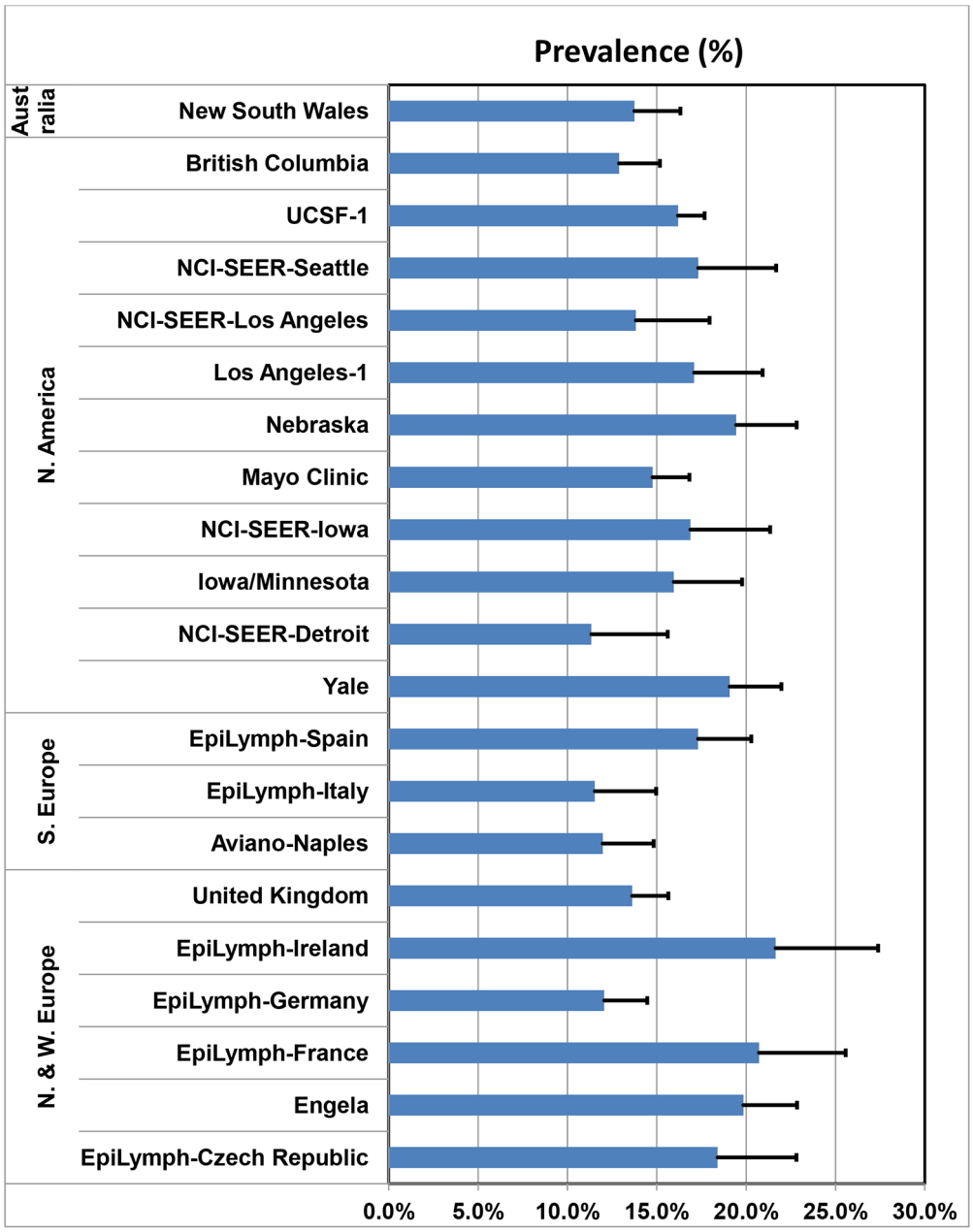

Figure 1.

Prevalence of blood transfusion in the control group by region and study, adjusted for age at enrollment and sex

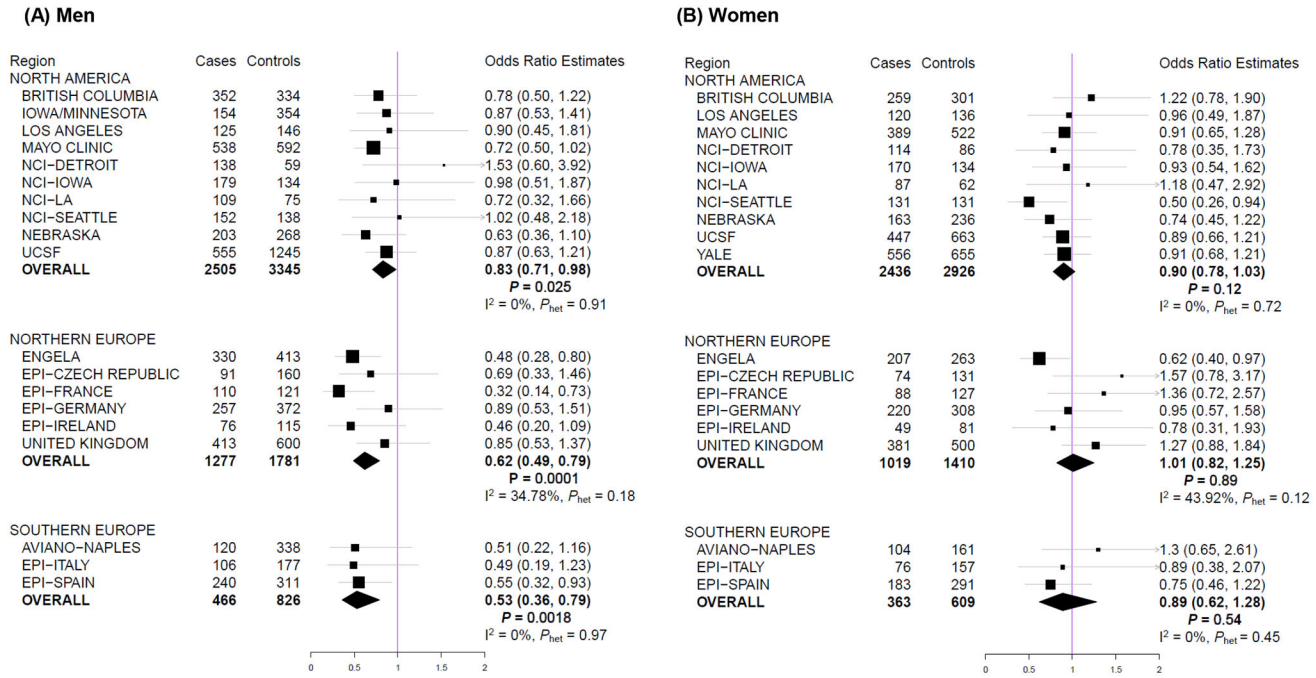

Figure 2.

Forest plot of the association of blood transfusion (ever, never) with risk of all NHL for non-Hispanic white men (A) and women (B) by geographic region

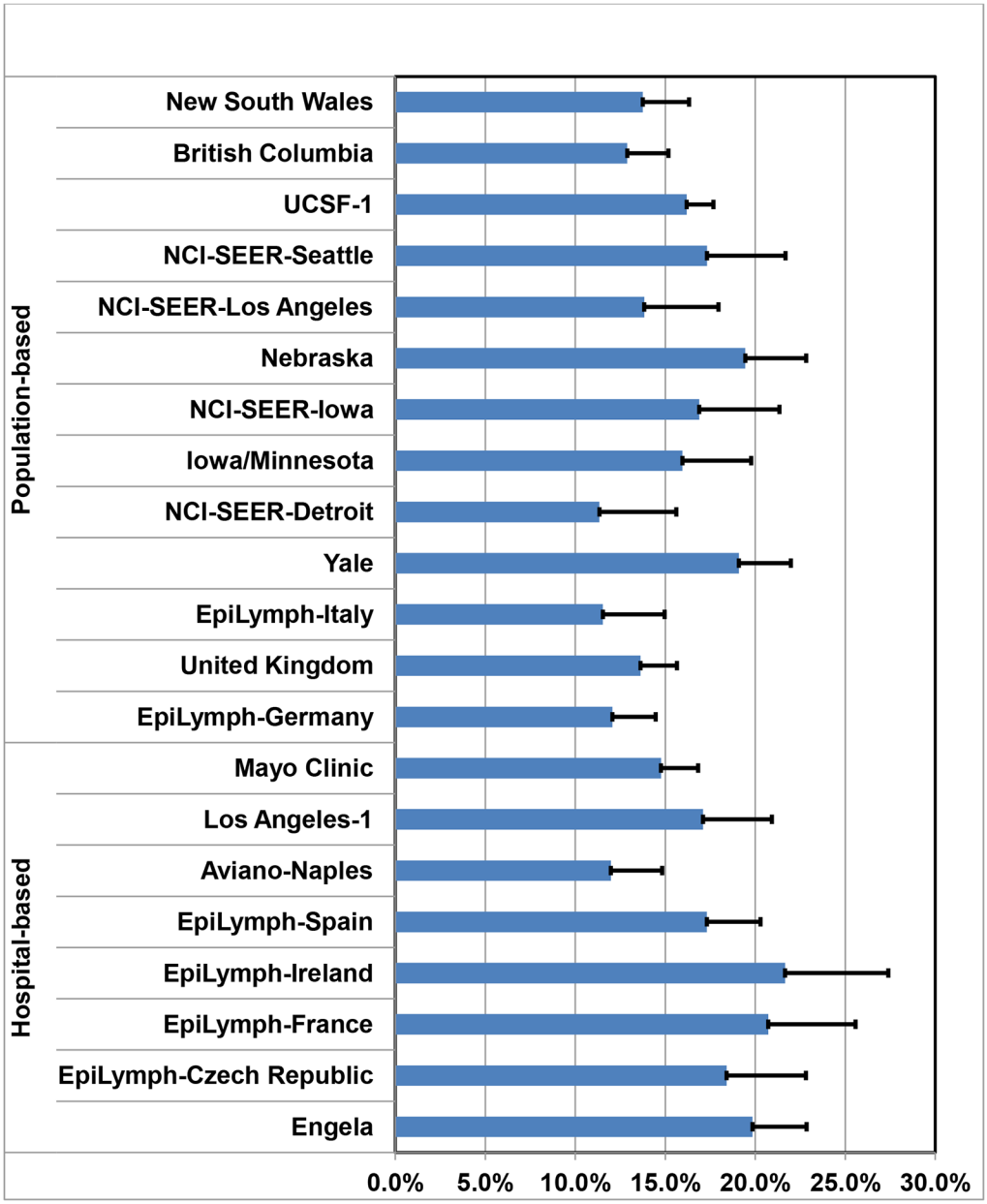

Figure 3.
Forest plot of the association of blood transfusion (ever, never) with risk of NHL subtypes for white men (A) and women (B)

Table 1.

Characteristics of case-control studies included in the pooled analysis

						Cases		Controls
Study Name (reference)	**Location**	**Years**	**Age Range**	**Design**	**Pathology Classification**	**N**	**Participation Rate**	**N**	**Participation Rate**
British Columbia	Vancouver, Victoria, British Columbia (Canada)	2000–2004	20–82	Population-based	WHO/ICD-O-3	833	79%	848	46%
Engela	Bordeaux, Brest, Caen, Lille, Nantes, Toulouse (France)	2000–2004	18–76	Hospital-based	WHO/ICD-O-3	567	93%	722	97%
EpiLymph-Czech Republic	Single center in Czech Republic	2001–2003	18–80	Hospital-based	WHO	181	90%	304	60%
EpiLymph-France	Amiens, Dijon, Montpellier	2000–2003	18–80	Hospital-based	WHO	215	91%	276	74%
EpiLymph-Germany	Ludwigshafen/Upper Palatinate, Heidelberg/Rhine-Neckar County, Wurzburg/Lower Franconia, Hamburg, Bielefeld, Munich	1999–2002	18–80	Population-based	WHO	518	88%	710	44%
E pi Lymph-Ire land	Six hospitals on the East Coast of the Republic of Ireland	2001–2003	18–80	Hospital-based	WHO	136	90%	208	75%
EpiLymph-Italy	Sardinia	1998–2004	18–80	Population-based	WHO	183	93%	336	66%
EpiLymph-Spain	Barcelona, Tortosa, Reus and Madrid	1998–2004	18–80	Hospital-based	WHO	439	82%	631	96%
Iowa-Minnesota	Iowa and Minnesota (USA)	1981–1983	30–97	Population-based	Working Formulation	866	87%	1245	81%
Italy	Aviano and Naples, Italy	1999–2002	18–84	Hospital-based	WHO	225	97%	504	91%
Los Angeles	Los Angeles, California	1989–1992	17–79	Population-based	Working Formulation	378	45%	378	69%
Mayo Clinic	Minnesota, Iowa, Wisconsin	2002–2008	18+	Clinic-based	WHO	1128	69%	1319	69%
NCI-SEER	Detroit, Michigan; Iowa; Los Angeles, California; Seattle, Washington (USA)	1998–2001	20–70	Population-based	WHO/ICD-O-2	1321	76%	1057	52%
Nebraska	Nebraska (USA)	1999–2002	20–75	Population-based	WHO	386	74%	533	77%
New South Wales	New South Wales, Australian Capital Territory (Australia)	2000–2001	20–74	Population-based	WHO/ICD-O-3	694	85%	694	61%
UCSF	San Francisco, California (USA)	1988–1995	21–74	Population-based	Working Formulation	1302	72%	2402	78%
United Kingdom	Yorkshire, Lancashire, South Lakeland and parts of Southwest England	1998–2003	16–69	Population-based	ICD-O-3	833	70%	1142	69%
Yale	Connecticut (USA)	1995–2001	21–84	Population-based	REAL	600	72%	717	47%−69%
Total						10805		14026	

Table 2.

Association of blood transfusion with risk of NHL for whites by sex

	Men							Women						
	Controls		Cases					Controls		Cases				
Transfusion exposure	**N**	**%**	**N**	**%**	**OR***	**95% CI**		**N**	**%**	**N**	**%**	**OR***	**95% CI**	
History of blood transfusion														
No	5473	86.9%	4111	89.4%	1.00	reference		4205	80.8%	3307	81.4%	1.00	reference	
Yes	824	13.1%	488	10.6%	0.74	0.65	0.83	997	19.2%	754	18.6%	0.92	0.83	1.03
Missing	1123		925					150		122				
Number of blood transfusions														
One	540	8.6%	303	6.6%	0.70	0.60	0.81	675	13.0%	544	13.4%	1.01	0.89	1.14
Two or more	241	3.9%	157	3.4%	0.81	0.65	1.00	301	5.8%	196	4.8%	0.76	0.63	0.92
Missing	1166		953					171		136				
Years from 1st transfusion to date of diagnosis/interview														
1–4 years	130	2.1%	76	1.7%	0.76	0.57	1.02	96	1.8%	65	1.6%	0.86	0.62	1.18
5–9 years	131	2.1%	81	1.8%	0.75	0.56	1.00	100	1.9%	70	1.7%	0.88	0.65	1.21
10–20 years	217	3.4%	142	3.1%	0.82	0.66	1.02	182	3.5%	137	3.4%	0.95	0.76	1.20
21–39 years	237	3.8%	119	2.6%	0.64	0.51	0.81	410	7.9%	328	8.1%	0.97	0.83	1.14
40+ years	109	1.7%	70	1.5%	0.73	0.54	1.00	209	4.0%	154	3.8%	0.86	0.69	1.07
Missing	1123		925					150		122				
Age at 1 st transfusion (years)														
≤20	141	2.2%	97	2.1%	0.91	0.70	1.19	135	2.6%	103	2.5%	0.96	0.74	1.25
21–30	140	2.2%	65	1.4%	0.61	0.45	0.82	273	5.2%	249	6.1%	1.13	0.95	1.36
31–40	109	1.7%	62	1.3%	0.71	0.51	0.97	222	4.3%	143	3.5%	0.78	0.63	0.97
41–50	127	2.0%	66	1.4%	0.68	0.50	0.92	150	2.9%	117	2.9%	0.94	0.73	1.20
51–60	134	2.1%	91	2.0%	0.79	0.60	1.05	99	1.9%	58	1.4%	0.70	0.50	0.97
>60	173	2.7%	107	2.3%	0.72	0.56	0.93	118	2.3%	84	2.1%	0.84	0.63	1.13
Missing	1123		925					150		122				
Era of first transfusion														
<1970	210	3.4%	113	2.5%	0.77	0.61	0.98	358	7.1%	267	6.8%	0.94	0.79	1.11
1970s	141	2.3%	56	1.2%	0.58	0.42	0.79	167	3.3%	152	3.9%	1.18	0.94	1.48
1980s	186	3.0%	114	2.5%	0.85	0.67	1.09	168	3.3%	109	2.8%	0.86	0.67	1.10
1990+	190	3.1%	107	2.4%	0.66	0.52	0.84	155	3.1%	106	2.7%	0.92	0.71	1.19
Missing	1220		1023					299		242				

* OR (odds ratio) and 95% CI (confidence intervals), adjusted for age at diagnosis/interview and study center.

Table 3.

Prevalence of selected risk factors by sex and blood transfusion status among controls

	Men				Women			
	Never Transfused		Ever Transfused		Never Transfused		Ever Transfused	
	N	%	N	%	N	%	N	%
Socioeconomic status								
low	3342	35.0%	524	40.1%	2977	39.7%	799	45.7%
medium	2945	30.9%	404	30.9%	2410	32.2%	588	33.7%
high	3257	34.1%	379	29.0%	2100	28.0%	359	20.5%
Family history of hematologic malignancy								
No	8162	93.9%	1129	94.2%	6214	92.5%	1442	91.4%
Yes	532	6.1%	70	5.8%	504	7.5%	136	8.6%
Body mass index (BMI)								
≤30 kg/m^2	6674	83.2%	858	80.8%	5530	83.4%	1244	80.2%
>30 kg/m^2	1348	16.8%	204	19.2%	1100	16.6%	307	19.8%
Smoking								
Never	2905	35.2%	316	28.6%	3625	55.2%	834	54.5%
Former	3407	41.2%	561	50.9%	1761	26.8%	451	29.5%
Current	1948	23.6%	226	20.5%	1185	18.0%	246	16.1%
Alcohol								
Never	802	16.5%	114	17.3%	1659	40.2%	451	43.0%
Former	460	9.4%	88	13.4%	393	9.5%	106	10.1%
Current	3606	74.1%	456	69.3%	2074	50.3%	493	47.0%
Recreational sun exposure								
Quartile 1–2	2104	44.5%	238	38.6%	2865	64.2%	688	68.9%
Quartile 3–4	2626	55.5%	378	61.4%	1600	35.8%	311	31.1%
Rheumatoid arthritis								
No	8891	97.0%	1150	93.0%	6774	94.9%	1514	91.4%
Yes	275	3.0%	87	7.0%	358	5.00%	142	8.6%
Hay fever								
No	4791	79.7%	703	82.9%	4087	78.0%	924	76.3%
Yes	1218	20.3%	145	17.1%	1151	22.0%	287	23.7%
HCV Serology								
Negative	3688	96.8%	491	95.0%	2527	97.3%	513	94.0%
Positive	120	3.2%	26	5.0%	70	2.7%	33	6.0%