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# Cohort Profile: The Korean Vietnam War Veterans' Health Study Cohort (KOVECO)

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**Abstract:** During the Vietnam War, many troops and citizen were exposed to large amounts of Agent Orange (AO), and the hazardous effects of AO are continuously being researched and reported. The Korean Vietnam War Veterans' Health Study Cohort (KOVECO) is a retrospective cohort to demonstrate the health status of the Korean Vietnam War veterans and their second-generation offsprings. The KOVECO is a collaboration of data from the Ministry of Patriots and Veterans Affairs and the National Health Insurance Sharing Service from 2002 to 2018. The study participants were all Korean Vietnam War veterans and their second-generation offsprings, and the references were the general population in which gender and region were matched with the participants. As of 2002, 191,272 Vietnam War veterans (1,000,320 comparisons) and 1,963,402 s-generations (1,173,061 references) were included in the cohort. The KOVECO consists of personal information, medical facility visit information, and general health examination information. The KOVECO could act as a health surveillance system, which would be able to detect long-term health effects caused by exposure to AO and provide a direction for policy making through academic research.

**Keywords:** KOVECO; Agent Orange; Vietnam War

## 1. Introduction

During the Vietnam War, many troops and citizens were killed or wounded and exposed to unknown threats, such as Agent Orange (AO). Large amounts of AO were widely used during the Vietnam War as a tactical herbicide without consideration of its human health effect [1]. Its hazardous effects are continuously being researched and reported [2–4]. Approximately more than 300,000 troops from the Republic of Korea participated in the Vietnam War. The Ministry of Patriots and Veterans Affairs (MPVA) of Korea has been rewarding veterans who participated in the war by providing medical services and welfare, which include tracking sequelae caused by AO since 1995. Epidemiologic research was performed five times in the period of 1995–2016. Although each study obtained remarkable results, they had limitations since the data used in the research were from individual research institutes. Through this study, we tried to establish a cohort with representativeness, reproducibility, and public confidence using national data.

The Korean Vietnam War Veterans' Health Study Cohort (KOVECO) was established to perform the sixth epidemiologic study to find out the long-term health effects, in terms of unveiled sequelae, of AO on Korean Vietnam War veterans, including women troops, and the health effects on the second generation [5].

## 2. Materials and Methods

### 2.1. Cohort Description

#### 2.1.1. Data and Participants

The KOVECO is a collaboration of data from the MPVA and data from the National Health Insurance Sharing Service (NHISS). The MPVA had a list and identification information, such as name, age, sex, national identification number, family, address, and war participation information (rank, affiliation, class, date of entry into the war, or date of retirement). The MPVA defined participants of the KOVECO as extraction based on national identification number with war participation information from records accessed on 1 January 2021. The NHISS had a public database that was followed up annually on health care utilization, health screening, medical facility visit history, prescription or procedure information, sociodemographic variables, and mortality for the whole population of Korea from 2002 to 2018 [6]. The NHISS data were merged into data from the MPVA based on national identification numbers. The data merging was performed by a data expert who was independent from all researchers or relatives, and the national identification number was converted to a unique NHISS number in order to prevent individual backtracking or leakage of personal information. Data from the NHISS were collected using written informed consent from all participants, and the information was anonymized. The study was approved by the Institutional Review Board of Gachon University Gil Medical Center (IRB No. GCIRB2019-076).

The study participants included all Korean Vietnam War veterans and their second generation with an age-, region-, and sex-matched cohort. All available general populations were used as a reference group and matched by age, sex, and region with a 1:5 ratio to minimize the effects of their differences. Table 1 shows the baseline characteristics of the KOVECO in 2002. We collected information on gender and type of participants (Vietnam War veteran, second generation, and each reference). In 2002, there were 191,272 Vietnam War veterans (1,000,320 references) and 1,963,402 s-generation (1,173,061 references). The proportion of females was 0.2% of the veterans (0.2% of the reference group) and 41.1% of the second generation (40.3% of the reference group).

**Table 1.** Baseline characteristics of the Vietnam War veteran and second-generation cohort in 2002.

| | Vietnam War Veteran | | Reference | | Second Generation | | Reference | |
|---|---|---|---|---|---|---|---|---|
| | N | (%) | N | (%) | N | (%) | N | (%) |
| Total | 191,272 | | 1,000,320 | | 377,262 | | 1,963,402 | |
| Male | 190,976 | (99.8) | 998,840 | (99.8) | 222,389 | (58.9) | 1,173,061 | (59.7) |
| Female | 296 | (0.2) | 1480 | (0.2) | 154,873 | (41.1) | 790,341 | (40.3) |

Table 2 shows the distribution by year of the KOVECO during the follow-up period (2002–2018). As the years passed, the overall number of participants in all groups decreased. During the follow-up period, the total person-years of Vietnam War veterans were 3,213,250 (15,329,931 person-years in the reference) and those of the second generation were 6,042,386 (38,328,109 person-years in the reference).

Table 3 shows the distribution by region of the KOVECO in 2002. In both the veteran group and the second-generation group including each reference, the number of participants is highest in Seoul (26.8% of the veteran group, 25.7% of the second-generation group), followed by Gyeonggi (15.2% and 17.8%) and Busan (9.4% and 7.7%).

**Table 2.** Distribution by year of the Vietnam War veteran and second-generation cohort during follow-up period.

| Year | Vietnam War Veteran | Reference | Total | Second Generation | Reference | Total |
|---|---|---|---|---|---|---|
| 2002 | 191,272 | 1,000,320 | 1,191,592 | 377,262 | 1,963,402 | 2,340,664 |
| 2003 | 190,696 | 988,177 | 1,178,873 | 374,724 | 1,952,094 | 2,326,818 |
| 2004 | 190,193 | 976,347 | 1,166,540 | 372,332 | 1,941,740 | 2,314,072 |
| 2005 | 189,797 | 964,266 | 1,154,063 | 369,898 | 1,932,997 | 2,302,895 |
| 2006 | 189,611 | 952,740 | 1,142,351 | 367,753 | 1,925,204 | 2,292,957 |
| 2007 | 189,405 | 941,312 | 1,130,717 | 365,398 | 1,918,802 | 2,284,200 |
| 2008 | 189,304 | 929,792 | 1,119,096 | 362,857 | 1,912,283 | 2,275,140 |
| 2009 | 189,214 | 918,159 | 1,107,373 | 360,244 | 1,906,333 | 2,266,577 |
| 2010 | 189,064 | 906,102 | 1,095,166 | 357,348 | 1,899,631 | 2,256,979 |
| 2011 | 188,869 | 893,209 | 1,082,078 | 354,125 | 1,891,888 | 2,246,013 |
| 2012 | 188,745 | 880,229 | 1,068,974 | 350,858 | 1,884,912 | 2,235,770 |
| 2013 | 188,142 | 865,206 | 1,053,348 | 347,296 | 1,877,446 | 2,224,742 |
| 2014 | 187,809 | 852,719 | 1,040,528 | 343,902 | 1,870,625 | 2,214,527 |
| 2015 | 187,756 | 838,368 | 1,026,124 | 340,420 | 1,863,553 | 2,203,973 |
| 2016 | 187,760 | 823,267 | 1,011,027 | 336,696 | 1,856,044 | 2,192,740 |
| 2017 | 187,777 | 807,341 | 995,118 | 332,678 | 1,848,411 | 2,181,089 |
| 2018 | 187,836 | 791,014 | 978,850 | 328,595 | 1,840,358 | 2,168,953 |
| Total (person-year) | 3,213,250 | 15,329,931 | 18,543,181 | 6,042,386 | 32,285,723 | 38,328,109 |

**Table 3.** Distribution by city of the veteran and second-generation cohort in 2002.

| City | Vietnam War Veteran | Reference | Total (% of Column) | Second Generation | Reference | Total (% of Column) |
|---|---|---|---|---|---|---|
| Seoul | 52,451 | 266,688 | 319,139 (26.8) | 105,040 | 496,945 | 601,985 (25.7) |
| Busan | 19,143 | 93,234 | 112,377 (9.4) | 34,419 | 146,156 | 180,575 (7.7) |
| Daegu | 9042 | 53,381 | 62,423 (5.2) | 21,792 | 95,629 | 117,421 (5.0) |
| Incheon | 9423 | 49,698 | 59,121 (5.0) | 16,385 | 93,923 | 110,308 (4.7) |
| Gwangju | 4786 | 26,523 | 31,309 (2.6) | 11,349 | 51,743 | 63,092 (2.7) |
| Daejeon | 4957 | 26,386 | 31,343 (2.6) | 10,627 | 52,676 | 63,303 (2.7) |
| Ulsan | 3740 | 19,212 | 22,952 (1.9) | 8742 | 38,980 | 47,722 (2.0) |
| Gyeonggi | 32,796 | 148,894 | 181,690 (15.2) | 60,720 | 355,175 | 415,895 (17.8) |
| Gangwon | 6402 | 31,775 | 38,177 (3.2) | 11,981 | 63,140 | 75,121 (3.2) |
| Chungbuk | 4582 | 27,814 | 32,396 (2.7) | 9184 | 59,889 | 69,073 (3.0) |
| Chungnam | 5944 | 40,558 | 46,502 (3.9) | 10,853 | 78,727 | 89,580 (3.8) |
| Jeonbuk | 6999 | 40,451 | 47,450 (4.0) | 13,903 | 79,560 | 93,463 (4.0) |
| Jeonnam | 7785 | 48,431 | 56,216 (4.7) | 15,227 | 86,356 | 101,583 (4.3) |
| Gyeongbuk | 9969 | 58,011 | 67,980 (5.7) | 21,282 | 114,964 | 136,246 (5.8) |
| Gyeongnam | 11,246 | 58,372 | 69,618 (5.8) | 21,906 | 127,136 | 149,042 (6.4) |
| Jeju | 2007 | 10,892 | 12,899 (1.1) | 3852 | 22,403 | 26,255 (1.1) |
| Total | 191,272 | 1,000,320 | 1,191,592 (100) | 377,262 | 1,963,402 | 2,340,664 (100) |

### 2.1.2. Measurement and Variables

The variables in the KOVECO are summarized in Table 4. The KOVECO consists of three databases based on a participant's personal information, medical facility visit information, and general health examination information [7]. The personal information database contains 10 variables, including the standard year for the eligibility of the insured, the participant's personal identification (ID), sex, birth date, district of residence, type of eligibility, percentile group of income level, grade of disability registered, type of disability registered, and type of group (Vietnam War veterans with references and second generation with references). The medical facility visit information database contains 17 variables, including the participant's personal ID, key sequence number of claim, medical care institution identification number, first day of receiving treatment, form of claimed bill, medical subject code, main and subdisease code, first date of inpatient, route

through hospitalization, days of receiving medical care and visit hospitals or inpatient, total days of prescription, extra rate applied based on claims reviewed, amount of medical expenses, expenses paid by beneficiary, and expenses paid by insurer based on claims reviewed. The general health examination information database contains 18 variables, including date of examination, the participant's personal ID, past history (stroke, cardiovascular diseases, hypertension, diabetes, dyslipidemia, tuberculosis, and others including cancer), medical treatment history (stroke, cardiovascular diseases, hypertension, diabetes, dyslipidemia, tuberculosis, and others, including cancer), family history (stroke, cardiovascular diseases, hypertension, diabetes, dyslipidemia, tuberculosis, and others, including cancer), health behavior (smoking, alcohol consumption, and exercise level), anthropometry (height, weight, waist circumference, body mass index, visual acuity, hearing acuity), blood pressure (systolic blood pressure, diastolic blood pressure, and pulse rate), urine spot test, hemoglobin, fasting blood glucose, lipid profile (total cholesterol, triglyceride, HDL cholesterol, and calculated LDL cholesterol), serum creatinine, aspartate aminotransferase (AST), alanine aminotransferase (ALT), gamma-glutamyl transpeptidase (gamma GTP), glomerular filtration rate, and measurement method of glomerular filtration rate. Table 3 shows the distribution by region of the KOVECO in 2002. In both the veteran group and the second-generation group including each reference, the number of participants is highest in Seoul (26.8% of the veteran group, 25.7% of the second-generation group), followed by Gyeonggi (15.2% and 17.8%) and Busan (9.4% and 7.7%).

**Table 4.** List of variables in the KOVECO database.

| Database | Details |
| --- | --- |
| Personal information (10) | Standard year for the eligibility of the insured<br>Personal ID<br>Sex (male, female)<br>Birth date<br>District of residence<br>Type of eligibility<br>Percentile group of income level<br>Grade of disability registered<br>Type of disability registered<br>Type of group (Vietnam War veteran with reference and second generation with reference) |
| Medical facility visit information (17) | Personal ID<br>Key sequence number of claim<br>Medical care institution identification number<br>The first day of receiving treatment<br>Form of claimed bill<br>Medical subject code<br>Main disease code (Ko)<br>Subdisease code<br>First date of inpatient<br>Route through hospitalization<br>Days of receiving medical care<br>Days of visit hospitals or inpatient<br>Total days of prescription<br>Extra rate applied based on claims reviewed<br>Amount of medical expenses based on claims reviewed<br>Amount of expenses paid by beneficiary based on claims reviewed<br>Amount of expenses paid by insurer based on claims reviewed |

**Table 4.** *Cont.*

| Database | Details |
|---|---|
| General health examination information (18) | Date of examination<br>Personal ID<br>Past history (stroke, cardiovascular diseases, hypertension, diabetes, dyslipidemia, tuberculosis, and others, including cancer)<br>Medical treatment history (stroke, cardiovascular diseases, hypertension, diabetes, dyslipidemia, tuberculosis, and others, including cancer)<br>Family history (stroke, cardiovascular diseases, hypertension, diabetes, dyslipidemia, tuberculosis, and others, including cancer)<br>Health behavior (smoking, alcohol consumption, and exercise level)<br>Anthropometry (height, weight, waist circumference, body mass index, visual acuity, hearing acuity)<br>Blood pressure (systolic blood pressure, diastolic blood pressure, and pulse rate)<br>Urine spot test<br>Hemoglobin<br>Fasting blood glucose<br>Lipid profile (total cholesterol, triglyceride, HDL cholesterol, and calculated LDL cholesterol)<br>Serum creatinine<br>AST (SGOT)<br>ALT (SGPT)<br>Gamma GTP<br>Glomerular filtration rate<br>Measurement method of glomerular filtration rate |

## 3. Results

Table 5 shows the distribution of medical facility visit history by year of the KOVECO during the follow-up-period (2002–2018). The prevalence of medical facility visits of the Vietnam War veterans had a gradually increasing tendency, and the average prevalence was 2.10 per year. The prevalence of medical facility visits of the Vietnam War veterans was significantly higher by 11% than those of the reference group in all years in 2002–2018 except 2011 (total prevalence ratio: 1.11; 95% confidence interval (95% CI): 1.1109–1.1142).

**Table 5.** Distribution of medical facility visit history by year of the Vietnam War veteran and second-generation cohort during follow-up period.

| Year | Cases of Vietnam War Veteran | Prevalence of Medical Facility Visit of Vietnam War Veteran | Prevalence Ratio Compared with General Population | 95% Confidence Interval |
|---|---|---|---|---|
| 2002 | 228,857 | 1.20 | 1.05 | (1.04–1.06) |
| 2003 | 254,735 | 1.34 | 1.06 | (1.05–1.07) |
| 2004 | 281,540 | 1.48 | 1.08 | (1.07–1.09) |
| 2005 | 314,949 | 1.66 | 1.09 | (1.08–1.10) |
| 2006 | 336,040 | 1.77 | 1.09 | (1.08–1.10) |
| 2007 | 359,613 | 1.90 | 1.09 | (1.08–1.09) |
| 2008 | 386,402 | 2.04 | 1.08 | (1.08–1.09) |
| 2009 | 406,807 | 2.15 | 1.08 | (1.08–1.09) |
| 2010 | 424,660 | 2.25 | 1.09 | (1.08–1.09) |
| 2011 | 228,857 | 1.21 | 0.95 | (0.94–0.96) |
| 2012 | 471,628 | 2.50 | 1.12 | (1.11–1.12) |
| 2013 | 481,380 | 2.56 | 1.11 | (1.10–1.12) |
| 2014 | 493,512 | 2.63 | 1.12 | (1.12–1.13) |
| 2015 | 503,866 | 2.68 | 1.12 | (1.11–1.12) |
| 2016 | 519,312 | 2.77 | 1.13 | (1.12–1.13) |
| 2017 | 525,993 | 2.80 | 1.12 | (1.11–1.13) |
| 2018 | 544,915 | 2.90 | 1.13 | (1.12–1.14) |
| Total (person-year) | 6,756,385 | 2.10 | 1.11 | (1.11–1.12) |

## 4. Discussion

The KOVECO represents the whole Korea by using all dispatched troops to the Vietnam War and their second-generation offsprings and the entire Korean general population as reference. It includes various kinds of national representative health information, such as diseases, deaths, and medical examinations, which could be used widely. The data are annually established on December 31 of each year, and it is possible to continuously evaluate the health status of the Vietnam War veterans.

The study is limited by the nature of data from the NHISS. Although most of the veterans are of old age, the data had to be constructed from 2002 to 2018 as a retrospective cohort. Thus, it is difficult for the KOVECO to demonstrate acute or early-onset diseases of the Vietnam War veterans. The diagnosis codes were not sometimes perfectly matched with real diseases because the Korean national health insurance was based on a fee-for-service system [8]. However, the vague disease status is expected to be overcome using this cohort through other information, such as prescriptions, procedures, or inpatient records in a future study.

## 5. Conclusions

The KOVECO is a retrospective cohort to demonstrate the health status of the Korean Vietnam War veterans and their second-generation offsprings. The cohort consists of an annual database and could be updated annually. The cohort includes medical facility visit information, disease or death status, medical examination results, and medical expenses, which could be analyzed in various ways. The benefit of this cohort is the inclusion of the whole Korean population, which can make an extraction of differences of health statuses of the Korean Vietnam War veterans from the general population. The KOVECO could act as a health surveillance system, which would be able to detect the difference between the Vietnam War veteran group and the reference group in unhealthy status described by the prevalence of medical facility visit and provide a direction for policy making through academic research. Furthermore, the KOVECO could describe the health statuses and medical needs of the Vietnam War veterans, and it might be helpful in understanding the health effects of exposure to AO on not only the Korean Vietnam War veterans but the global Vietnam War veterans and citizens who were involved in the Vietnam War.

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