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分担研究報告書

既存統計資料に基づくがん対策進捗の評価手法に関する実証的研究

がん検診における無料クーポン政策の評価

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研究要旨

背景と目的：がん検診にかかるための費用を軽減することは、乳がん検診（マンモグラフィー検診）の受診率を高めるとのエビデンスが示されている一方、子宮がん検診（Pap スメア検査）の受診率を上げるかどうかについては十分なエビデンスはない。日本では、2009 年に 140 億円を投じて、マンモグラフィー検診およびPap スメア検診にかかる費用を無料とするクーポンを発行する事業が導入された。20, 25, 30, 35, 40 歳に対して子宮頸がん検診クーポン、40, 45, 50, 55, 60 歳に対して乳がん検診クーポンが配布された。本研究の目的は無料クーポン導入の前後においてがん検診受診率ならびに社会経済要因によるがん検診受診率格差を比較することにより、コストも含めて無料クーポン政策導入の効果について評価することである。

研究方法：日本を代表するサンプルを有する繰り返し横断調査データを用いた Difference-In-Differences 法による準実験モデル分析を実施した。評価指標はがん検診受診率の上昇（%）、がん検診受診を 1 人増やすのに要した平均費用（円）および政策導入前後における 8 つの格差指標の推移である。2007 年および 2010 年の国民生活基礎調査個票データから入院入所中の者を除き、政策の対象となった年齢層の女性 34,043 人を分析対象とした。

研究結果と考察：無料クーポンにより Pap スメアでは 13.9%、マンモグラフィーでは 9.8%の受診率上昇が認められ、がん検診受診者を 1 人増やすために平均 13,100 円のコストを要していた（年齢・所得調整モデル）。こういった分析の結果を政策の優先順位決定過程に導入する必要があるかもしれない。

格差指標はそれぞれ反映する格差の側面が異なるため、場合によっては相反した推移を示すことがある。そのため、単一の格差指標ではなく、できるだけ多くの指標で評価することが必要とされる。がん検診受診率格差に関しては無料クーポン導入群で、乳がん検診において格差の縮小（-12.9%から-74.1%)が認められた一方、子宮頸がん検診においては格差の拡大（+100%以上）が認められた。この違いは年齢層の違いに由来しているかもしれない。20-40 歳（子宮頸がん検診）では健康意識が低い状態にあり、がん検診が知られておらず、無料ということに加えて情報提供に反応したのかもしれない。40-60 歳（乳がん検診）ではすでに最も恵まれた集団はがん検診を受診していたため、無料クーポンによって恵まれない集団の受診が促進され、受診率格差が縮小したのかもしれない。

まとめ：無料クーポンはがん検診受診率を上昇させるかもしれないが、費用についても考慮する必要があろう。また無料クーポンが与えるがん検診受診率格差への影響に関してもモニタリングする必要があると考えられた。

A. 背景および研究目的

日本では、政府や厚生労働省によって実施されてきた医療政策について、どれだけの効果があり、どれだけの費用を要したのか等の政策評価が十分には実施されてきていない。がん検診事業は国民全体に対するポピュレーションアプローチ戦略のもと、ポピュレーション全体のがん死亡のリスクを軽減することを目的として実施されてい

るが、モニタリング体制は十分ではない。一方、画一的なポピュレーションアプローチでは社会的に恵まれた集団と比較して恵まれない集団ではリスクの軽減が小さい、すなわち、格差は逆に拡大する傾向が指摘されている。実際、日本における医療保険別のがん検診受診率は、2010 年の国民生活基礎調査によると市町村国保加入者において共済組合加入者よりも約 25-40%ポイント受診率が低く、がん検診受診率は医療保険別に大きな格差があることが明らかになった (日本医事新報, 4605: 84-88, 2012)。こういった状況のなか「健康日本 21（第 2 次）」では目標として「健康格差の縮小」が掲げられたが、格差をどのように測定し、どのように格差の推移を評価するのかという点についても知見は十分ではない。

そこで、本研究では日本で 2009 年度から実施されている乳がんおよび子宮頸がん検診の無料クーポン政策について受診率の増加および所得階級毎の受診率格差、費用を評価することを目的とする。

Introduction

Breast cancer is the most commonly diagnosed female cancer worldwide. Cervical cancer is the third most commonly diagnosed but is a smaller problem in Japan.[1] Every 2 years women are invited for screening in accordance with recommendations by the Japanese Advisory Committee on Cancer Screening. Women of 20 years or more (no upper age limit) are invited for cervical cancer screening (CCS) (Pap smear) and women of 40 years or more (no upper age limit) are invited for breast cancer screening (BCS) (mammography), through local municipal governments or workplace-based medical insurances.[2] Despite national cancer screening recommendations and evidence for prevention and early detection of cancer, female cancer screening (FCS) attendance rates remain low. A possible reason for this is the absence of a population based FCS system.[3] The current system is composed of various different structures implemented by local municipalities or workplaces, each with different approaches to individual elements of the system (e.g., out-of-pocket costs setting, letters of invitation, no guideline for workplace-based cancer screening).[4] FCS is performed either as part of a health checkup for residents offered by a local municipal government or a workplace-based health checkup in accordance with the Industrial Safety and Health Act. If housewives and unemployed women are covered by workplace-based medical insurances for entire families, they may not attend the local government residential checkups. This makes it difficult for municipal staff to select a target population for FCS and improve FCS attendance rates. In 2007, only 24.5% of women aged 20-69 years reported having CCS and 23.8% of women aged 50-69 years reported having BCS, within the past year.[5] These figures are considerably lower than those for other developed countries such as the USA, Canada, Germany, The Netherlands, Korea, and Australia.[5]

In 2009, the Japanese government introduced a new, politically determined policy which provided cost-free CCS and BCS attendance. Although financial barriers to screening are generally reduced in most European countries where free tests are available,[6] out-of-pocket costs have been a barrier to access in the USA and Japan.[7] To increase access to BCS, interventions to reduce or eliminate out-of-pocket costs have been recommended, especially for the lower socioeconomic population, aimed at reducing socioeconomic inequality in cancer screening attendance.[7-9] However, to date, there is insufficient evidence to determine whether reducing out-of-pocket costs is effective in increasing CCS attendance, and thus, an evidence gap was identified.[7, 9] Data on cost from interventions for cancer screening attendance are also limited.[7, 10] This quasi-experimental study aims to fill the evidence gap that has arisen in the absence of a governmental strategy to evaluate the intervention in Japan.

Socioeconomic inequalities in mortality, morbidity and health-related behaviors, including cancer screening attendance, have been demonstrated worldwide.[11, 12] Attendance levels at FCS for Japanese women in the lowest quintile of household income were approximately half those of women in the highest quintile.[13] Inequalities in cancer screening are responsible for the higher mortality rate among people of lower socioeconomic position because of the associated decrease in the chance of early detection of cancer.[14, 15] Broad policy frameworks, such as the World Health Organization Commission on the Social Determinants of Health report and the Japanese health promotion plan "Healthy Japan 21 (2nd)", present moral arguments for reducing health inequalities.[16, 17] In addition to improving overall attendance, addressing inequalities in uptake must remain a priority for screening programs.[18, 19]

We utilized repeated cross sections as a quasi-experimental study, which includes two consecutive population-based studies of Japanese people, observed pre- and postintervention. Our objective is to evaluate uptake and average cost per uptake of the intervention on CCS and BCS attendances and to assess socioeconomic inequalities in FCS attendance pre- and postintervention.

B-E.

Material and Methods

Data

We used data from pre- and postintervention cross-sectional studies: the 2007 and 2010 Comprehensive Survey of Living Conditions of People on Health and Welfare (CSLCPHW), conducted by the Japanese Ministry of Health, Labour and Welfare (MHLW).[20] The CSLCPHW collects information on health-related factors, such as cancer screening and smoking behavior, every three years. Out of 940,000 inhabited census tracts (sampling unit for national census in 2005), 5,440 were randomly sampled across Japan in 2007 (5,510 in 2010) for the collection of data from all household members within each census tract. Of 11,000 units (around 5,500 census tracts were further divided into 11,000 units for appropriate alignment of territory management), 2,000 units were randomly selected across Japan for the income survey. Income data were available for 23,513 (response rate; 64.8%) households in 2007 and 26,115 (72.6%) in 2010. Data were used with permission from MHLW.

Intervention and FCS attendance

The intervention was implemented from September 2009 to March 2010 across Japan and was intended to increase uptake of attendance for Pap smear or mammography. It comprised two elements. First, vouchers were distributed (usually by mail but occasionally by hand)[4] to remove out-of-pocket costs to clients, and second, the vouchers were accompanied by small media (information leaflets). All women reaching the first year in a 5-year age group were invited to attend, that is, aged 20, 25, 30, 35, and 40 years on 31 March 2009 (identified from municipal resident registries) for Pap smear and aged 40, 45, 50, 55, and 60 years for mammography.[2] The invitees themselves made appointments for the tests (although these were rarely necessary for Pap smear tests, they were often required for mammography) at any local providers. Upon presentation of the voucher, they received the FCS without out-of-pocket costs. We assembled groups of women aged ±1 and ±2 years of the intervention group as a comparison group.

Attendance for FCS was surveyed preintervention (2007) and postintervention (2010) as follows. "Have you participated in cervical (breast) cancer screening in the past 12 months? (CCS means Pap smear test; BCS means mammography or breast echography.) (yes/no)". Because only cancer screening modalities of Pap smear and mammography were affected by the intervention and these are the most common programs in Japan,[2, 4, 21] we assumed that CCS means Pap smear, and BCS means mammography (not echography). As the surveys were conducted in early June, "the past 12 months" could include the total intervention term.

Evaluation framework

We used a Difference-in-Differences (DID) approach[22] to evaluate the effect of the intervention on uptake of FCS attendance. Intervention effectiveness can be evaluated by comparing pre- and postscreening attendance in the intervention and comparison groups. However, because crude comparisons of pre- and postoutcomes may be contaminated by the effect of biased characteristics that differ between the two groups, we applied not only the unadjusted DID method but also the covariate-adjusted DID method[23] with a propensity score weight[24] calculated using data on potential covariates such as age and employment status, which mitigated differences in individual traits across intervention and comparison groups.

Covariates

Covariates related to cancer screening attendance were used to present characteristics of study subjects and to control for their possible confounding effects. In line with previous studies,[13, 25-30] we used (*i*) household income, (*ii*) age, (*iii*) housing tenure (home-owner or not), (*iv*) employment status, (*v*) marital status (married, never married or widowed/divorced), (*vi*) household structure (living alone, single mother, couple, couple with unmarried child, three-generation family or other), (*vii*) current smoker (yes/no), (*viii*) self-rated health (excellent, very good, good, fair or poor), (*ix*) health checkup in the last year (yes/no), (*x*) regular hospital visit for major physical disease (yes/no), (*xi*) regular hospital visit for obstetric and gynecologic disease (yes/no) and (*xii*) metropolitan areas (yes/no).

For household income, to adjust for family size and composition, the OECD modified equivalent scale was used with a weight of 1.0 for the first adult, 0.5 for any other household member aged 14 years and over, and 0.3 for each child aged below 14 years.[27, 31] The study subjects were categorized into quintiles according to the equivalent household income.

Five year categories of women aged 23-42 and 43-62 years in 2009 were analyzed for CCS and BCS, respectively. This was because women aged 20 years in 2009 were not included for CCS and those aged 40 years in 2009 were not included for BCS, as they were ineligible for cancer screening in 2007 (e.g., women aged 20 years in 2009 were 18 in 2007, and 21 in 2010).

Statistical analysis

Of 34,982 women who were age eligible and had income data, 34,043 noninstitutionalized women (16,044 in 2007 and 17,999 in 2010) were analyzed in this study. The basic characteristics were tabulated according to intervention and comparison groups. The proportion of women in each intervention and comparison group who had attended FCS in the past 12 months was tabulated according to covariates. Chi-square or Fisher's exact tests (when the expected values in any of the cells of a contingency table are below 5) were used to compare the difference in subject characteristics and FCS attendance between intervention and comparison groups. The effect of the intervention on uptake of FCS attendance was estimated by the DID method with unadjusted, age- and income-adjusted and fully-adjusted models.

Probability values for statistical tests were two-tailed and $p<0.05$ was regarded as statistically significant. All statistical analyses, other than inequality indicators, were performed using SAS version 9.2 (SAS Institute, Cary, NC).

Average cost per uptake

For a brief consideration of cost, average cost per uptake[32] of FCS (equally assuming 1 uptake for each CCS and BCS attendance) was calculated by dividing total expenditure by the absolute total number estimate of FCS uptake resulting from the intervention. Total governmental expenditure for the intervention, including additional municipality staff processing costs for the intervention, was reported as 14 billion yen ($US148 million) in 2009.[2] Absolute total uptake was estimated by multiplying the unadjusted, age- and income-adjusted, and fully-adjusted DID point estimates by census population.[33]

Monitoring inequality indicators

To monitor and evaluate inequality in FCS attendance, attendance inequalities according to household income were calculated because income is a representative socioeconomic factor.[34] Because there is debate about inequality measurement methods, and interpretation of results can change depending on the inequality indicator used, full consideration of the broadest range of measurement was recommended.[35] Therefore, we used absolute and relative indicators of inequality[36]: rate difference, between-group variance and absolute concentration index for absolute inequality and rate ratio, index of disparity, relative concentration index, Theil index and mean log deviation for relative inequality. Detailed explanations of these indicators are given elsewhere.[37, 38] As these indicators are measured on different scales, we compared the overall change in inequality by calculating the percentage change in each indicator,[36, 37] using HD*calc software (version 1.2.1) from the National Cancer Institute.[39]

Results

Basic characteristics of the study subjects are shown in Table 1 (see also supplementary Table S1). A statistically significant difference between the intervention and comparison groups was observed in some categories. For example, employment status in 2007 for the CCS group (proportion "not working" was 28.6% for the intervention group *vs.* 32.9% for the comparison group); and marital status, health checkup and regular hospital visit for obstetric and gynecologic disease in 2007 and self-rated health in 2010 for the BCS group.

FCS attendance rates according to basic characteristics are shown in Table 2 (figures are shown in supplementary Table S2). In 2007, although overall CCS or BCS attendance rates did not differ significantly between the intervention and comparison groups (21.6 *vs.*

22.5% for CCS; 27.4 *vs.* 29.2% for BCS, respectively), a statistically significant difference for attendance rates between the intervention and comparison groups was observed in the 23-27 years age group (4.2 *vs.* 8.6%), fourth household income quintile (21.7 *vs.* 27.3%), not working (29.1 *vs.* 24.5%), never married (9.0 *vs.* 11.9%), and health checkup yes group (25.3 *vs.* 30.0%) for CCS, first household income quintile (14.4 *vs.* 20.0%) and three-generation family (27.1 *vs.* 32.8%) for BCS. In 2010, the intervention group had significantly higher overall attendance rates than the comparison group (43.3 *vs.* 30.3% for CCS; 43.4 *vs.* 32.5% for BCS, respectively). Similarly, most characteristic categories showed that the intervention group had significantly higher attendance rates than the comparison group, except for small sample categories such as widowed/divorced marital status, living alone and missing.

The increase and DID estimates (effect sizes) of FCS uptake (percentage) from 2007 to 2010, according to household income quintile and age group, are shown in Table 3. Although the intervention group had a higher than 15% increase in FCS attendance rates (21.7% for CCS and 16.0% for BCS), there was a 7.8% (95% confidence interval: 6.2-9.4) increase for CCS and 3.3% (1.9-4.8) for BCS in the comparison group. DID estimates for overall population were 13.9% (12.2-15.7) in the unadjusted model, 13.9% (9.6-18.2) in the age- and income-adjusted model and 13.8% (9.5-18.1) in the fully-adjusted model for CCS and 12.7% (10.9-14.5) in the unadjusted model, 9.8% (5.7-13.9) in the age- and income-adjusted model and 9.8% (5.7-13.9) in the fully-adjusted model for BCS. The observed effect (uptake) according to income quintile was not proportional across the quintiles, that is, for CCS, the third income quintile had the highest DID estimate, whereas the second quintile had the lowest with nonsignificance in the covariate-adjusted models. For BCS, the first-fourth income quintiles significantly showed positive values in the DID estimates, whereas the fifth quintile did not show positive values in the covariate-adjusted models (noting wide confidence interval); that is, 5.4% (3.5-7.3) in the unadjusted model, 0.5% (-9.8 to 10.9) in the age- and income-adjusted model and 2.6% (-7.8 to 13.0) in the fully-adjusted model for the fifth quintile. Women in the older age group generally indicated lower estimates for both CCS and BCS than the younger, with the oldest age group for BCS representing nonsignificant positive value in the covariate-adjusted models, that is, although the 23-27 years age group had 17.3-17.8% of DID estimates for CCS, the 38-42 years age group had 10.0-13.3%; although the 43-47 years age group had 12.1-16.4% of DID estimates for BCS, the 58-62 years age group had 4.8-10.1%.

In the calculation for average cost per uptake, using the results of the unadjusted DID estimates according to age, the absolute total number of uptakes of FCS attendance in Japan resulting from the intervention was estimated as 1.20 million. Thus, the average cost per uptake was estimated as 11,600 yen (approximately US$123). When the age- and income-adjusted or fully-adjusted DID estimates were applied, the average cost per uptake was 13,100 yen (US$139) or 13,400 yen (US$142), respectively.

Table 4 shows estimates and percentage changes of inequality indicators for FCS attendance according to household income quintile within each intervention and comparison group in 2007 and 2010. In the CCS groups all absolute and relative inequality indicators increased, with a wide range, among both the intervention and comparison groups. In the BCS comparison group, although three absolute inequality indicators slightly increased, ranging from 15.9 to 43.9%, five relative indicators did not materially change with negative value for rate ratio. In the BCS intervention group, all indicators decreased, ranging from -12.9 to -74.1%.

Discussion

The cost-removal intervention, which uses distribution of vouchers combined with small media, has increased CCS attendance by 13.9% and BCS attendance by 9.8% according to the age- and income-adjusted DID model in Japan, which is a developed country with a low FCS attendance rate. Using the results of income-adjusted DID estimates according to age, the absolute total number of women attending BCS in Japan as a result of the intervention was estimated as 472,000. The total number of deaths that could be avoided by the increase in BCS attendance was calculated as 461 (based on the calculations for total screening numbers required to avoid one death[40]). According to national vital statistics 12,204 women died from breast cancer in 2010[41]; hence, the avoidable number represents 3.8% of annual cause-specific death by breast cancer. As the number needed to screen for CCS was not available, we used the detection rates for cervical cancer by CCS by age groups according to the Japanese government report for health promotion project in 2009,[42] and the number of cases detected due to the increase in CCS attendance (13.9%) was estimated as 519. This can reduce death and preserve fertility.[43]

As described in the introduction, although out-of-pocket cost reduction has been recommended for BCS, there is a gap in the evidence as to whether such an intervention will increase attendance for CCS, especially in Asian countries.[7] This study contributes evidence to this field with special consideration of inequality and cost. Implementation of this policy needs considerable spending, with an average cost of more than US$100 per uptake. This is more expensive than most other intervention modalities for increasing FCS, such as client reminders or one-to-one education.[44, 45] Previous research has shown that even small out-of-pocket costs decrease the use of preventive care services.[46] In particular, for women of low socioeconomic position, cancer screening may be an unaffordable luxury, with competing out-of-pocket medical and nonmedical expenses, including prescription drugs, dental care and eating out.[7] Elimination of out-of-pocket costs for cancer screening access might be more favorable than reduction but needs a larger budget.

The intervention not only improved overall FCS attendance but also affected the magnitude of inequality in attendance.[47] Although the intervention might increase inequality for CCS, it might decrease inequality for BCS, in accordance with existing literature.[8, 47] A number of possible reasons exist for this. First, there were inequalities that had already increased before the intervention; that is, the magnitude of inequality in 2007 was small for CCS but relatively large for BCS. Therefore, inequality variations might widen for CCS but narrow for BCS. Second, related to the first point, different personal compositions, such as age, marital status, and regular hospital visit, might cause a difference between CCS and BCS. Elderly affluent women might have attended BCS before the intervention. Women in the highest income quintile might therefore show a lower attendance increase for BCS resulting from the intervention than those in other quintiles. The early years of public health interventions such as FCS are often damaging in terms of health equity.[47, 48] The inverse equity hypothesis of Victora *et al.*[49] proposes that affluent sections of society preferentially benefit from, or exploit, such interventions, leading to an initial increase in inequalities (early stage). Deprived sections only begin to catch up once affluent sections of society have extracted the maximum possible benefit (late stage).[50] The younger CCS group may be in the early stage of the FCS intervention (younger women might have less time for FCS due to busy schedules than older women) and the older BCS group may be in the late stage. Third, lack of knowledge about cancer is a predictor of nonattendance at cancer screening.[29] Because different levels of knowledge about FCS are expected among the CCS and BCS groups according to their different characteristics such as age, the small media intervention, often combined with cost-removal vouchers,[7] might differently influence the CCS and BCS groups. However, the impact of this is uncertain because data on the separate effects of small media were unavailable. In a previous study, the educational intervention was less effective than cost removal among the low-income population,[51] whereas lack of knowledge was a more significant reason for nonattendance than economic obstacles among the high-income population.[29, 52]

In terms of inequality indicators, not only absolute but also relative inequality indicators showed consistent trends, indicating the robustness of the results for inequality trend[35] as the strength of this study. Inequality indicators can lead to contradictory conclusions on whether inequalities in health have narrowed or not.[37] In fact, relative and absolute approaches inevitably contradict each other when populations have the same proportionate reductions in risk. Since the different approaches can lead to very different priorities for action, some researchers suggest absolute indicators deserve primacy.[53] All indicators provide mathematically accurate measures of the change in overall inequality among these populations, but they reflect different normative judgments about what to consider when measuring equality.[35] Since 180° opposite interpretations can emerge when using only biased indicators, we need to evaluate inequality carefully, using broad indicators.

Another strength of our study was the large sample size for general applicability, representing the total Japanese population with a small baseline (2007) difference between intervention and comparison groups. Because this study is based on repeated cross sections instead of longitudinal data, changes to one individual could not be specified. Longitudinal studies, however, have the problem that disadvantaged people are likely to leave the study.[54] In this study, all respondents with characteristics of disadvantage could be included; this study design may thus complement longitudinal studies.

There are possible limitations to this study. First, as the information was self-reported, the study might not be free from biases, especially misclassification bias.[55] As this questionnaire was not designed for evaluation of the intervention, several modalities might be included in cancer screening. However, this would not change the DID results as the intervention only affected Pap smear and mammography testing. Second, our analysis could not distinguish whether the testing was being performed for screening or diagnostic purposes. Furthermore, although both physicians' behavior and people's knowledge and attitudes towards preventive care are important determinants of FCS attendance,[29] we could not include them because no data were collected in the survey. Third, some Japanese municipalities already deliver free FCS services to all eligible residents: 6.6% for CCS and 5.9% for BCS in January 2009.[4] This may lead to underestimation of the intervention effect. Fourth, average cost per uptake was calculated without considering switching costs. Because around 20-25% of the invitees used the vouchers in 2009 according to the government report[2] and uptake was estimated to be around 10-15% in this study, it is estimated that, as a result of the intervention, around 10% of the invitees switched from their past practice (e.g., workplace-based FCS) to using vouchers in their community with associated opportunity costs. Although opportunity costs for switching FCS attendance (e.g., absence from work to attend FCS in the community in contrast to workplace-based FCS) were not available, the switch of financial source, which may lead to overestimation on the results of average cost per uptake, should be taken into account.

In conclusion, our results suggest removal of out-of-pocket costs could potentially make a substantial contribution to FCS uptake and reduction of inequalities in BCS delivery due to household income inequality but may not be cost-saving. Careful and thoughtful consideration of the feasibility of continuing the intervention policy in terms of benefits and costs is required. This consideration should take account of the equity perspective as well as medical and economic factors. This study adds to a growing body of literature showing that we may need to invest extra efforts in reducing inequalities in cancer screening uptake.[56] In addition to uptake levels and average cost per uptake, policymakers should carefully consider the role of inequalities in the design of screening programs, to ensure that screening attendance pathways are closely monitored from an equity perspective.[57] Judgment as to whether a particular distribution of health is just, fair, or socially acceptable may guide the interpretation of the data. Policymakers and researchers must therefore pay more attention to the normative choices inherent in measurement on which they base their evaluations of current and future health policies for remedying health inequalities.[35] Although the cost-removal intervention appears to have been successful in improving overall uptake for FCS during the first year of implementation, it is essential to continue monitoring attendance rates, average cost per uptake and socioeconomic inequality for FCS as the system matures.

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Abbreviations

Cervical cancer screening (CCS); Breast cancer screening (BSC); Female cancer screening

(FCS); Comprehensive Survey of Living Conditions of People on Health and Welfare (CSLCPHW); Ministry of Health, Labour and Welfare (MHLW)

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Disclosure

The authors have declared no conflicts of interest.

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Table 1. Basic characteristics of the study subjects.

Characteristics	Cervical cancer screening group				Breast cancer screening group			
	2007		2010		2007		2010	
	Intervention (n=1,465), %	Comparison (n=5,628), %	Intervention (n=1,606), %	Comparison (n=6,146), %	Intervention (n=1,874), %	Comparison (n=7,077), %	Intervention (n=2,000), %	Comparison (n=8,247), %
Household income								
1st (lowest) quintile	18.4	20.4	20.4	19.9	19.6	20.1	19.3	20.3
2nd quintile	21.2	19.7	19.9	20.0	19.3	20.2	20.6	19.8
3rd quintile	19.0	20.3	18.9	20.3	21.0	19.7	20.8	19.8
4th quintile	21.1	19.7	19.4	20.2	20.5	19.9	20.2	19.9
5th (highest) quintile	20.3	19.9	21.3	19.7	19.6	20.1	19.2	20.2
Age group in 2009†								
23-27	19.5	18.6	19.6	18.5	-	-	-	-
28-32	22.7	22.7	23.6	23.4	-	-	-	-
33-37	31.3	29.9	28.8	29.4	-	-	-	-
38-42	26.6	28.8	28.0	28.7	-	-	-	-
43-47	-	-	-	-	21.1	21.5	21.1	21.7
48-52	-	-	-	-	21.1	22.3	21.1	21.4
53-57	-	-	-	-	23.9	25.2	24.5	24.9
58-62	-	-	-	-	33.9	31.1	33.4	32.0
Home owner								
No	34.7	36.0	33.7	32.8	15.4	15.9	16.2	16.0
Yes	65.3	64.0	66.3	67.2	84.6	84.1	83.9	84.0
Employment status								
Not working	28.6*	32.9*	31.5	31.0	30.6	30.4	36.0	34.6
Small scale less than 100 employees	25.9	24.1	25.3	25.8	23.8	23.6	22.0	22.1
Medium scale 100 to 499 employees	12.7	10.9	10.7	13.0	10.3	9.5	8.7	9.3
Large scale more than 500 employees	12.4	11.2	12.6	11.4	7.6	7.3	8.9	8.9
Public office	5.8	4.6	4.4	5.0	5.1	5.0	4.3	4.2
Unknown scale	5.3	4.7	4.1	3.8	4.0	4.2	3.0	3.2
Self-employed/Others	9.0	11.4	11.0	9.7	18.6	19.9	16.7	17.5
Missing	0.3	0.3	0.3	0.3	0.1	0.1	0.6	0.2
Marital status								
Married	55.2	56.5	63.7	63.6	83.6*	83.3*	81.4	82.3
Never married	39.7	38.1	30.8	30.8	4.9	6.4	5.5	6.1
Widowed/Divorced	5.1	5.3	5.5	5.6	11.5	10.3	13.2	11.7
Household structure								
Living alone	3.8	4.8	4.0	4.0	4.8	4.8	6.5	6.2
Single mother	6.7	6.8	6.5	6.9	5.7	6.1	6.3	5.9
Couple	8.0	7.9	8.5	8.0	16.7	18.2	23.3	24.0
Couple with unmarried child	53.4	53.7	56.4	56.8	38.2	37.9	35.2	33.6
Three generation family	21.7	20.6	18.8	18.5	22.4	21.4	16.5	17.6
Others	6.4	6.1	5.7	5.7	12.3	11.7	12.3	12.7
Current smoker								
No	78.9	79.7	78.4	79.3	83.4	82.9	78.7	80.3
Yes	18.4	17.6	15.7	15.4	11.6	11.8	9.6	9.5
Missing	2.7	2.7	5.9	5.3	5.0	5.3	11.8	10.2
Self-rated health								
Excellent	22.5	23.2	21.4	20.8	13.9	14.1	12.9*	13.0*
Very good	20.1	18.9	18.6	17.8	15.7	15.6	12.5	14.2
Good	44.5	44.5	41.3	44.1	50.6	49.6	47.5	48.4
Fair	7.6	8.9	9.6	9.3	12.1	11.9	11.6	11.2
Poor	0.8	0.9	1.3	1.2	0.9	1.3	1.7	1.0
Missing	4.6	3.7	7.8	6.9	6.9	7.5	13.9	12.2
Health check-up in the last year								
No	44.4	46.2	40.3	41.6	35.0*	32.6*	29.3	30.1
Yes	53.9	51.5	58.6	57.6	63.2	64.6	68.3	67.7
Missing	1.7	2.3	1.1	0.8	1.8	2.8	2.5	2.1
Regular hospital visit for major physical disease								
No	93.6	95.9	92.2	91.6	77.6	78.0	70.7	72.4
Yes	4.1	2.4	5.5	6.3	19.4	19.5	27.3	25.9
Missing	2.3	1.7	2.4	2.1	3.0	2.5	2.1	1.7
Regular hospital visit for obstetric and gynecologic disease								
No	95.2	95.9	95.6	96.0	96.6*	96.4*	96.7	97.2
Yes	2.5	2.4	2.0	1.9	0.4	1.1	1.3	1.1
Missing	2.3	1.7	2.4	2.1	3.0	2.5	2.1	1.7
Metropolitan areas								
No	81.9	81.7	78.5	78.3	84.4	84.4	82.4	82.7
Yes	18.1	18.3	21.5	21.7	15.6	15.6	17.7	17.3

†Categorized by age in 31 March 2009.

Note. P values for difference between intervention and comparison groups were obtained using chi-square tests.

*P<.05 The * mark was only placed by the first covariate factor of the characteristic.

Table 2. Cervical and breast cancer screening attendance rates according to basic characteristics

Characteristics	Cervical cancer screening group: Cervical cancer screening attendance rates, 2007: Intervention (n=1,465), %	2007: Comparison (n=5,628), %	2010: Intervention (n=1,606), %	2010: Comparison (n=6,146), %	Breast cancer screening group: Breast cancer screening attendance rates, 2007: Intervention (n=1,874), %	2007: Comparison (n=7,077), %	2010: Intervention (n=2,000), %	2010: Comparison (n=8,247), %
Overall population	21.6	22.5	43.3*	30.3*	27.4	29.2	43.4*	32.5*
Household income								
1st (lowest) quintile	20.7	17.4	39.3*	22.8*	14.4*	20.0*	33.9*	24.2*
2nd quintile	22.2	21.7	37.2*	25.5*	26.5	26.2	38.7*	27.5*
3rd quintile	20.5	22.5	45.7*	29.8*	26.0	29.8	42.5*	30.4*
4th quintile	21.7*	27.3*	44.2*	35.5*	32.2	33.2	52.0*	36.7*
5th (highest) quintile	22.6	23.7	49.7*	37.8*	37.6	36.7	49.9*	43.6*
Age group in 2009†								
23-27	4.2*	8.6*	33.0*	19.9*	-	-	-	-
28-32	20.1	18.9	42.7*	27.6*	-	-	-	-
33-37	23.6	26.2	46.9*	34.8*	-	-	-	-
38-42	33.2	30.4	47.2*	34.5*	-	-	-	-
43-47	-	-	-	-	26.3	27.6	50.0*	34.8*
48-52	-	-	-	-	25.5	29.7	44.7*	33.4*
53-57	-	-	-	-	29.9	29.6	43.7*	32.5*
58-62	-	-	-	-	27.4	29.5	38.2*	30.3*
Home owner								
No	27.1	24.8	45.7*	30.3*	18.3	19.2	33.4*	22.9*
Yes	18.6	21.2	42.1*	30.2*	29.0	31.0	45.3*	34.3*
Employment status								
Not working	29.1*	24.5*	43.9*	30.0*	24.4	25.1	41.6*	28.9*
Small scale less than 100 employees	19.8	20.6	44.0*	27.5*	29.0	30.3	46.1*	31.4*
Medium scale 100 to 499 employees	17.7	20.5	44.8*	29.6*	25.4	26.9	44.5*	36.5*
Large scale more than 500 employees	17.0	24.4	41.9*	33.2*	32.4	34.1	45.2	40.7
Public office	18.8	26.9	62.0*	44.1*	42.1	52.7	58.1	56.2
Unknown scale	13.0	18.9	22.7	25.2	28.0	29.1	35.0	30.4
Self-employed/Others	22.0	20.8	41.5*	31.4*	25.3	27.5	41.0*	29.6*
Missing	0.0	6.7	0.0	10.5	0.0	12.5	9.1	20.0
Marital status								
Married	30.8	29.6	51.1*	35.5*	28.6	30.6	45.2*	33.5*
Never married	9.0*	11.9*	29.3*	19.8*	19.6	18.1	37.6*	25.7*
Widowed/Divorced	20.0	22.7	30.7	28.2	21.8	24.1	34.5	29.0
Household structure								
Living alone	16.1	22.7	36.9	34.8	14.4	21.6	35.4	28.7
Single mother	15.3	17.0	32.4*	20.9*	22.6	21.0	33.6	28.0
Couple	36.8	32.7	60.6*	41.2*	28.1	28.8	44.6*	32.8*
Couple with unmarried child	23.1	22.9	43.4*	30.4*	27.1	29.2	44.7*	31.0*
Three generation family	16.7	19.8	40.4*	27.8*	27.1*	32.8*	45.0*	36.0*
Others	16.0	21.2	42.9*	29.7*	34.8	30.5	44.3*	34.9*
Current smoker								
No	22.1	23.5	45.8*	32.7*	29.1	31.3	45.9*	35.1*
Yes	20.4	19.7	37.7*	21.8*	18.3	17.5	33.0*	19.9*
Missing	12.5	9.9	24.2	18.4	19.1	21.3	35.2*	24.1*
Self-rated health								
Excellent	17.6	20.6	45.6*	30.4*	23.8	28.8	43.8*	34.0*
Very good	23.4	25.4	43.1*	33.1*	28.9	31.8	44.4*	35.0*
Good	23.6	20.6	43.7*	30.3*	28.6	29.4	45.9*	33.7*
Fair	20.7	33.1	48.1*	31.2*	28.2	29.9	40.3*	29.8*
Poor	45.5	25.0	40.0	26.4	31.3	22.3	57.6*	23.8*
Missing	10.4	15.9	29.6	21.4	20.2	22.8	34.5*	26.4*
Health check-up in the last year								
No	17.8	15.2	27.0*	15.5*	5.6	4.7	14.2*	7.3*
Yes	25.3*	30.0*	55.3*	41.3*	40.2	42.7	57.3*	44.7*
Missing	0.0	0.0	0.0	2.0	0.0	2.5	6.1	1.7
Regular hospital visit for major physical disease								
No	21.4	22.2	43.9*	30.0*	27.0	28.9	42.5*	31.9*
Yes	30.0	32.6	39.8	36.4	29.2	31.3	46.2*	34.7*
Missing	11.8	11.5	26.3	24.4	25.0	21.1	39.0	24.5
Regular hospital visit for obstetric and gynecologic disease								
No	20.9	22.0	43.0*	29.8*	27.5	29.2	43.5*	32.4*
Yes	56.8	52.2	75.0	63.2	25.0	40.0	46.2	49.4
Missing	11.8	11.5	26.3	24.4	25.0	21.1	39.0	24.5
Metropolitan areas								
No	21.4	22.4	42.5*	29.8*	28.4	29.9	43.8*	32.8*
Yes	22.3	23.0	46.0*	32.1*	21.9	25.2	41.4*	30.9*

†Categorized by age in 31 March 2009.

Note. P values for difference between intervention and comparison groups were obtained using chi-square or Fisher's exact tests.

*P<.05

Table 3. Increase of cancer screening attendance, unadjusted and covariate-adjusted Difference-In-Differences estimates and 95% confidence intervals from 2007 to 2010.

	Increase (95%CI), %		Unadjusted DID	Age- and income-adjusted DID	Fully-adjusted DID
	Intervention	Comparison	estimate (95%CI), %	estimate (95%CI), %	estimate (95%CI), %
Cervical cancer screening					
Overall population	21.7 (18.5-24.9)	7.8 (6.2-9.4)	13.9 (12.2-15.7)	13.9 (9.6-18.2)*	13.8 (9.5-18.1)**
Household income					
1st (lowest) quintile	18.6 (11.4-25.8)	5.4 (2.1-8.6)	13.2 (11.6-14.9)	16.9 (7.6-26.3)†	17.3 (7.9-26.7)††
2nd quintile	15.0 (8.0-22.0)	3.8 (0.4-7.3)	11.2 (9.5-12.9)	8.6 (-0.6-17.8)†	8.1 (-1.2-17.3)††
3rd quintile	25.2 (17.9-32.6)	7.3 (3.8-10.8)	17.9 (16.2-19.7)	18.0 (8.1-28.0)†	17.9 (7.9-27.9)††
4th quintile	22.6 (15.4-29.7)	8.2 (4.5-11.9)	14.4 (12.6-16.2)	11.1 (1.2-21.0)†	11.4 (1.5-21.2)††
5th (highest) quintile	27.2 (20.0-34.3)	14.1 (10.4-17.8)	13.0 (11.2-14.8)	15.2 (5.1-25.2)†	14.6 (4.7-24.6)††
Age group in 2009§					
23-27	28.8 (23.1-34.5)	11.3 (8.4-14.1)	17.5 (16.2-18.9)	17.8 (10.6-24.9)‡	17.3 (10.3-24.3)‡‡
28-32	22.6 (16.0-29.2)	8.6 (5.5-11.8)	14.0 (12.3-15.7)	14.2 (5.4-23.0)‡	13.2 (4.5-21.8)‡‡
33-37	23.3 (17.3-29.3)	8.7 (5.6-11.7)	14.6 (12.8-16.4)	12.6 (4.2-20.9)‡	12.7 (4.5-21.0)‡‡
38-42	14.1 (7.5-20.6)	4.0 (0.9-7.2)	10.0 (8.1-11.9)	12.2 (2.9-21.6)‡	13.3 (4.0-22.7)‡‡
Breast cancer screening					
Overall population	16.0 (13.1-19.0)	3.3 (1.9-4.8)	12.7 (10.9-14.5)	9.8 (5.7-13.9)*	9.8 (5.7-13.9)**
Household income					
1st (lowest) quintile	19.5 (13.6-25.4)	4.2 (1.3-7.2)	15.3 (13.6-16.9)	12.7 (5.2-20.3)†	12.6 (5.0-20.1)††
2nd quintile	12.2 (5.6-18.7)	1.3 (-1.9-4.4)	10.9 (9.1-12.7)	10.6 (1.8-19.4)†	9.3 (0.4-18.1)††
3rd quintile	16.6 (10.2-23.0)	0.6 (-2.6-3.9)	16.0 (14.1-17.8)	12.7 (3.8-21.6)†	13.7 (5.0-22.5)††
4th quintile	19.8 (13.0-26.5)	3.5 (0.1-6.9)	16.3 (14.4-18.2)	12.0 (2.1-21.9)†	11.6 (1.8-21.4)††
5th (highest) quintile	12.3 (5.2-19.3)	6.9 (3.4-10.3)	5.4 (3.5-7.3)	0.5 (-9.8-10.9)†	2.6 (-7.8-13.0)††
Age group in 2009§					
43-47	23.7 (17.2-30.1)	7.2 (4.1-10.4)	16.4 (14.6-18.3)	13.1 (4.0-22.1)‡	12.1 (3.0-21.3)‡‡
48-52	19.2 (12.8-25.6)	3.7 (0.5-6.8)	15.5 (13.6-17.3)	13.8 (4.9-22.6)‡	13.6 (4.8-22.4)‡‡
53-57	13.8 (7.7-19.9)	3.0 (0.0-5.9)	10.8 (9.0-12.6)	8.9 (0.4-17.4)‡	10.0 (1.5-18.5)‡‡
58-62	10.8 (5.8-15.9)	0.8 (-1.8-3.3)	10.1 (8.3-11.9)	5.7 (-1.2-12.7)‡	4.8 (-2.0-11.6)‡‡

*Adjusted for household income quintile, age group.

†Adjusted for age group.

‡Adjusted for household income quintile.

**Adjusted for household income quintile, age group, housing tenure, employment status, marital status, household structure, current smoker, self-rated health, health check-up in the last year, regular hospital visit for major physical disease, regular hospital visit for obstetric and gynecologic disease, and metropolitan areas.

††Adjusted for age group, housing tenure, employment status, marital status, household structure, current smoker, self-rated health, health check-up in the last year, regular hospital visit for major physical disease, regular hospital visit for obstetric and gynecologic disease, and metropolitan areas.

‡‡Adjusted for household income quintile, housing tenure, employment status, marital status, household structure, current smoker, self-rated health, health check-up in the last year, regular hospital visit for major physical disease, regular hospital visit for obstetric and gynecologic disease, and metropolitan areas.

§Categorized by age in 31 March 2009.

Abbreviations, DID; Difference-In-Differences, CI; confidence interval

Table 4. Estimates and percent change of inequality indicators for cancer screening attendance according to household income quintile within each of intervention and comparison groups

Inequality indicators	Intervention			Comparison		
	2007 Estimate (95%CI)	2010 Estimate (95%CI)	Percent change, %	2007 Estimate (95%CI)	2010 Estimate (95%CI)	Percent change, %
Cervical cancer screening group						
Rate Difference*	2.06 (-4.66-8.77)	12.52 (5.03-20.01)	509.2	9.90 (6.48-13.32)	15.06 (11.46-18.67)	52.1
Between-Group Variance*	0.64 (-6.61-7.89)	20.18 (-2.78-43.15)	3063.8	10.25 (3.15-17.35)	32.81 (19.59-46.04)	220.1
Absolute Concentration Index*	0.25 (-0.95-1.45)	2.22 (0.88-3.57)	787.4	1.46 (0.86-2.07)	3.21 (2.57-3.86)	119.7
Rate Ratio	1.10 (0.80-1.50)	1.34 (1.12-1.60)	235.9	1.57 (1.34-1.84)	1.66 (1.46-1.88)	16.4
Index of Disparity	5.68 (-18.91-30.26)	16.27 (2.73-29.82)	186.7	21.93 (9.44-34.43)	24.97 (15.35-34.59)	13.8
Mean Log Deviation	0.69 (-2.99-4.37)	5.44 (-0.41-11.29)	688.5	10.48 (3.31-17.64)	18.27 (10.84-25.70)	74.4
Theil Index	0.69 (-2.98-4.36)	5.41 (-0.36-11.18)	685.6	10.24 (3.37-17.12)	18.00 (10.81-25.20)	75.7
Relative Concentration Index	1.16 (-4.43-6.76)	5.14 (2.02-8.26)	342.0	6.49 (3.82-9.16)	10.61 (8.48-12.73)	63.5
Breast cancer screening group						
Rate Difference*	23.16 (17.04-29.28)	18.04 (11.26-24.83)	-22.1	16.69 (13.44-19.95)	19.35 (16.20-22.49)	15.9
Between-Group Variance*	58.61 (29.38-87.83)	44.88 (15.43-74.34)	-23.4	33.31 (21.40-45.23)	47.95 (33.81-62.09)	43.9
Absolute Concentration Index*	4.12 (3.02-5.22)	3.59 (2.38-4.80)	-12.9	3.24 (2.65-3.82)	3.85 (3.28-4.41)	18.8
Rate Ratio	2.60 (1.96-3.45)	1.53 (1.30-1.81)	-66.9	1.83 (1.62-2.08)	1.80 (1.63-1.99)	-4.3
Index of Disparity	34.10 (15.52-52.68)	20.62 (8.41-32.83)	-39.5	25.64 (16.50-34.77)	31.85 (24.22-39.48)	24.2
Mean Log Deviation	46.98 (21.37-72.59)	12.17 (4.16-20.17)	-74.1	21.26 (13.32-29.19)	22.10 (15.58-28.62)	4.0
Theil Index	42.09 (21.20-62.98)	12.00 (4.23-19.77)	-71.5	20.26 (13.00-27.53)	22.27 (15.77-28.76)	9.9
Relative Concentration Index	15.05 (11.08-19.02)	8.27 (5.47-11.07)	-45.0	11.10 (9.09-13.10)	11.84 (10.09-13.58)	6.7

* Absolute indicator for inequality

Positive percent change means widening the inequality, whereas negative percent change means reducing the inequality.

Abbreviations: CI; confidence interval