ORIGINAL ARTICLE

Trend of sex ratio at birth in a public hospital in Hong Kong from 2001 to 2010

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Objectives To identify factors affecting the sex ratio at birth.

Design Cross-sectional study.

Setting Obstetric department of a public hospital in Hong Kong.

Participants All pregnant women delivered between 2001 and 2010.

Main outcome measures Sex ratio at birth versus women's eligibility status, age, parity, number of miscarriages or terminations of pregnancy, and number of fetuses were analysed using the Chi squared test. Multivariate regression was used to determine the effects of multiple factors on the sex of the newborn.

Results A total of 54 039 cases were reviewed. The sex ratio at birth changed since 2003, and became unbalanced (>107 males per 100 females) since 2006 revealed by a significant increase in males per 100 females, from 106.6 in 2001-2005 to 111.4 in 2006-2010. From 2001 to 2010, the sex ratio at birth increased from being balanced to becoming unbalanced in eligible persons, and became more unbalanced in non-eligible persons. The ratio increased in eligible persons after having two children, but in non-eligible persons after having one child. The sex ratio at birth was unbalanced (1.095) in singleton pregnancies, but balanced (1.019) in multiple pregnancies. Based on logistic regression, the chance of a male baby being born increased with parity of 2 or above (odds ratio=1.1; P<0.001), non-eligible person status (odds ratio=1.05; P=0.034), and delivery in the period 2006-2010 (odds ratio=1.04; P=0.019). The ratio was not increased with advanced maternal age, the number of miscarriages/terminations of pregnancy, and number of fetuses.

Conclusion Compared with 2001-2005, the sex ratio at birth became unbalanced in 2006-2010. An unbalanced ratio ensued in the latter period in both eligible and non-eligible persons, but to a greater extent and even after having one child in the latter group.

New knowledge added by this study

- There was a significant increase in the male/female ratio at birth, in eligible as well as non-eligible persons, from a balanced state in 2001-2005 to an unbalanced state (>107/100) in 2006-2010.
- The sex ratio at birth was balanced in women with multiple pregnancies.

Implications for clinical practice or policy

- Apart from establishing government policy and law, we advocate public education to promote gender equality.

Key words
Birth rate; Hong Kong; Pregnancy; Sex ratio

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Introduction

A male/female sex ratio at birth (SRB) of greater than 107 males per 100 females is considered high,[1,2] and will result in, after a few decades, a large excess of men. Consequently, many men will be deprived of marriage and parenting, and thus have adverse effects on the psycho-social well-being of individuals,[3] societal stability, and security.[4]

Imbalance in the SRB has been found in many countries, mainly in South and East Asia.[2] In a large population study in China involving 4.7 million persons, the SRB was close to normal for first-order births but was high for second-order births, especially in rural areas, where it reached 1.46.[3] The strong socio-cultural preference for sons in China is the

2001年至2010年間香港一所公立醫院中出生性別比率的趨勢

目的 探討影響出生性別比率的因素。

設計 橫斷面研究。

安排 香港一所公立醫院的產科部門。

參與者 2001年至2010年在本院分娩的孕婦。

主要結果測量 利用卡方檢驗分析出生性別比率與以下因素的關係：本地或非本地孕婦、年齡、產次、流產或終止妊娠的次數，以及嬰兒數目，並使用多元回歸分析探討多項因素對嬰兒性別的影響。

結果 研究期間共54 039名嬰兒在本院出生。出生性別比率自2003年起已有改變，而自2006年開始男女比例更出現不平衡的現象（每100名女性便有多於107名男性）。男性的出生率有上升趨勢；出生性別比率由2001-2005年的106.6增加至2006-2010年的111.4。從2001至2010年，本地孕婦的出生性別比率由平衡變成不平衡，非本地孕婦的情況更甚，特別是已有兩名子女的本地孕婦，和已有一名子女的非本地孕婦。出生性別比率在單胎妊娠中出現不平衡（1.095），而在多胎妊娠中則較為平衡（1.019）。邏輯迴歸分析顯示以下因素有較高機會誕下男嬰：已有兩名或以上子女的孕婦（比數比=1.1；P<0.001）、非本地孕婦（比數比=1.05；P=0.034）和2006-2010年間分娩（比數比=1.04；P=0.019）。然而，出生性別比率卻不受孕婦年齡、流產/終止懷孕次數和嬰兒數目影響。

結論 與2001至2005年比較，2006至2010年的出生性別比率較為不平衡。2006至2010年間無論本地或非本地孕婦，出生性別比率皆不平衡，尤以非本地孕婦以及她們當中已有一名子女的更甚。

likely underlying reason. The relationship between the SRB and the one-child policy is complex.[3] In Hong Kong, the one-child policy does not apply and the majority of its citizens (who are Chinese) have been exposed to western as well as Chinese education and culture. Hitherto, whether there was any unbalanced SRB in Hong Kong has not been fully investigated.

In a study on 3356 singleton deliveries in a Hong Kong public hospital from 1996 to 1998, the SRB was balanced in women having their first and second babies, but was high in parity-2 women with two daughters.[5] The finding of this small-scale study was confirmed by another study of a larger sample size (194 602 babies) collected in several hospitals from 2003 to 2007.[4] The SRB in Hong Kong Chinese was 106, 107, and 118 for parity 0, parity 1, and parity 2 or above, respectively.[4] It was suggested that the influx of Mainland Chinese women had exaggerated the male/female birth imbalance in Hong Kong.[4] Yet, it is not known whether SRB changes over years with maternal age, number of terminations, or in multiple pregnancies. We postulated that the SRB is more balanced in younger mothers as they may not have a strong socio-cultural preference for boys compared with older generations. A high SRB could also be related to persons having termination of pregnancy (TOP) if sex-selective abortion was being practised. Such high ratios may also occur in multiple pregnancies after assisted reproduction technology, if sex selection was also being practised with the procedure.

The objectives of this study were to determine the relationship between the SRB and eligibility status, maternal age, parity, number of miscarriages/TOP, and multiple pregnancies.

Methods

This was a retrospective study carried out at Queen Elizabeth Hospital, a tertiary obstetric unit in Hong Kong. The relevant data of all pregnant women who delivered from 2001 to 2010 were retrieved from the Obstetric Clinical Information System, in which the data were entered by midwives and doctors at different time points during the antepartum period and after delivery. The statistics generated from the database was checked regularly. Information on each woman's age, eligibility status, parity, number of miscarriages or TOPs, number of fetuses, and the gender of her babies was collected. Eligible persons (EPs) referred to Hong Kong residents who were eligible to subsidised medical services, while non-eligible persons (NEPs) included Mainland Chinese women travelling to Hong Kong to deliver babies. Those with singleton or multiple pregnancies were included. From our database, we could retrieve the total number of TOPs and spontaneous miscarriages, but could not differentiate between them. This study was approved by the Research Ethics Committee of the Kowloon Central Cluster.

The Statistical Package for the Social Sciences (Windows version 15.0; SPSS Inc, Chicago [IL], US) was used for analysis of the findings. The SRBs of all women and in EP and NEP groups were calculated. Besides, cases were subdivided arbitrarily into two periods: 2001-2005 and 2006-2010, because an influx of Mainland mothers after 2005 had resulted in a significant increase in the total number of births in Hong Kong. The patient's eligibility status, age, parity, number of miscarriages or TOPs, number of fetuses, and the gender of the baby were analysed using the Chi squared test. Stepwise multivariate logistic regression was used to determine the effects of multiple factors on the SRB.

Results

Between 1 January 2001 and 31 December 2010, a total

of 54 039 babies were born in our hospital. There were significant differences in the maternal characteristics in the periods 2001-2005 and 2006-2010 in that there was an increase in the SRB from 106.6/100 to 111.4/100 (Table 1). This ratio increased after 2003 and became unbalanced (>1.07) from 2006 (Fig). While the SRB in singleton pregnancies was 109.5/100 (ie >1.07) in multiple pregnancies it was 101.9/100 or nearly 1.

Overall, the SRB was greater than 107/100 in both EPs and NEPs, but was greater in the latter (113.0/100) than in the former (108.3/100) [P=0.039; Table 2]. In the EP group, there was a significant increase in the SRB from a balanced level in the period 2001-2005 to an unbalanced level in 2006-2010. In the NEP group, the SRB became more unbalanced from 2001-2005 to 2006-2010. The ratio increased in EP mothers after having two children, but in the NEP mothers it had increased after having one child. On the other hand, the SRB did not change significantly with maternal age or number of TOPs/miscarriages (Table 2).

Using logistic regression, it appeared that the chance having a male baby increased with parity of ≥2 (odds ratio [OR]=1.1; P<0.001), NEP status (OR=1.05; P=0.034), delivery during the period 2006-2010 (OR=1.04; P=0.019), but not with advanced maternal age, number of miscarriages/TOPs, and number of fetuses.

Discussion

We showed a significant increase in the SRB from a balanced state in 2001-2005 to becoming unbalanced (>107/100) in 2006-2010. This was attributed to an increased ratio in both EP and NEP mothers, although it was considerably higher in the latter. Our finding differed from a previous study suggesting that the increase in the SRB was solely attributed to NEPs.[4] Traditionally, the Chinese have a strong preference for sons,[6-10] because in olden days they were a source of manual power especially in rural areas. Sons are

TABLE 1. Male/female sex ratio at birth and maternal demographics versus period of delivery in Queen Elizabeth Hospital (n=54 039)

Demographics*	No. (%)†		P value
	Year 2001-2005 (n=24 539)	Year 2006-2010 (n=29 500)	
Male/female SRB (per 100 female births)	106.6	111.4	<0.001
Residency			<0.001
EPs	20 492 (84)	21 479 (73)	
NEPs	4047 (16)	8021 (27)	
Age (years)			<0.001
≥35	4610 (19)	6863 (23)	
<35	19 929 (81)	22 637 (77)	
No. of fetus			<0.001
Singleton	23 961 (98)	28 486 (97)	
Multiple	578 (2)	1014 (3)	
Gravida			<0.001
1 (n=17 664)	8342 (34)	9322 (32)	
2 (n=17 793)	8179 (33)	9614 (33)	
3 (n=10 482)	4643 (19)	5839 (20)	
≥4 (n=8100)	3375 (14)	4725 (16)	
Parity			<0.001
0 (n=28 733)	13 512 (55)	15 221 (52)	
1 (n=20 536)	8888 (36)	11 648 (39)	
2 (n=3803)	1672 (7)	2131 (7)	
≥3 (n=967)	467 (2)	500 (2)	
Miscarriage/termination of pregnancy			<0.001
0 (n=30 640)	14 236 (58)	16 404 (56)	
1 (n=14 522)	6556 (27)	7966 (27)	
2 (n=5871)	2540 (10)	3331 (11)	
≥3 (n=3006)	1207 (5)	1799 (6)	

* SRB denotes sex ratio at birth, EPs eligible persons, and NEPs non-eligible persons

† Unless otherwise specified

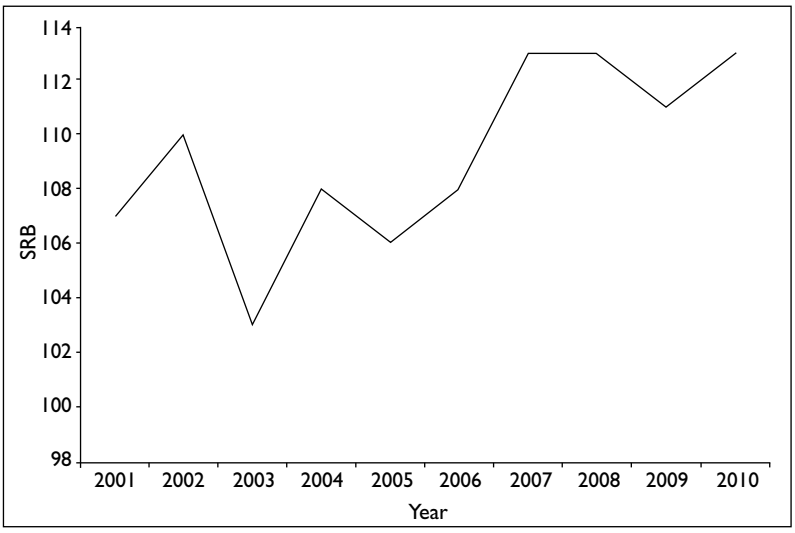

FIG. Trend of male/female sex ratio at birth (SRB) from 2001 to 2010 in Queen Elizabeth Hospital

TABLE 2. Male/female sex ratio at birth and maternal characteristics in eligible persons (EPs) and non-eligible persons (NEPs) in Queen Elizabeth Hospital (n=54 025)*

Characteristic	No. (per 100 female births)		P value
	EPs (n=41 959)	NEPs (n=12 066)	
Overall	108.3	113.0	0.039
Year			
2001-2005 (n=24 531)	106.3	108.0	0.632
2006-2010 (n=29 494)	110.2	115.6	0.071
P value	0.032	0.041	
Age (years)			
≥35 (n=11 466)	111.8	123.0	0.084
<35 (n=42 559)	107.2	111.6	0.071
P value	0.068	0.078	
Parity			
0 (n=28 722)	105.1	102.8	0.449
1 (n=20 534)	103.0	121.6	0.002
2 (n=3802)	120.1	153.9	0.005
≥3 (n=967)	121.4	145.5	0.383
P value	0.001	<0.001	
Miscarriage/termination of pregnancy			
0 (n=30 632)	106.7	114.3	0.015
1 (n=14 518)	110.9	114.3	0.445
2 (n=5869)	110.2	103.9	0.322
≥3 (n=3006)	108.9	115.5	0.345
P value	0.350	0.369	
Gravida			
1 (n=17 658)	103.6	105.2	0.688
2 (n=17 787)	108.4	113.9	0.169
3 (n=10 481)	112.0	115.4	0.518
≥4 (n=8099)	114.2	122.7	0.167
P value	0.004	0.044	
No. of fetuses			
Singleton pregnancies (n=52 438)	108.3	113.7	0.019
Multiple pregnancies (n=1587)	105.3	93.4	0.284
P value	0.652	0.043	

* The other 14 babies with ambiguous gender were excluded from the analysis

expected to produce generations with their family name and look after their parents. The preference for sons is evident in Hong Kong families.[4] This was despite there being no one-child policy as operated in Mainland China, and the fact that the majority of the local Chinese citizens having been exposed to western as well as Chinese education and culture. The total fertility rate fell steadily in Hong Kong during the past 20 years from the replacement level (ie two children per woman) to a level below one,[11,12] and this declining fertility rate was associated with an increase in the SRB.[13] This may explain the increasing ratio in EPs. However, improved economic conditions can lead to a decrease in the country's SRB, as there is a lower demand for manual power, and developed countries have greater acceptance of equal social and economic rights for males and females.[10] This may also explain our finding of a lower SRB in EPs than in NEPs.

According to the data from Census and Statistics Department in Hong Kong (Table 3), which included deliveries in all public and private hospitals,[14] the SRB became unbalanced from 2001 which was just when our present study began. We postulate that this might be related to difference in the characteristics of women using public as opposed to private hospitals, as a greater proportion of NEPs delivered in private hospitals. Under the one-child policy, some NEPs chose to delivery in Hong Kong after their first pregnancy. They could also be regarded as more willing to spend money on the pregnancy and deliver in private hospitals, if they knew they carried a male fetus. On the other hand, richer NEPs tend to deliver in private hospitals, no matter the gender of the fetus they were carrying. According to Knight et al,[15] richer households are more likely to have sons. Probably the SRB was therefore more unbalanced and became so earlier in private hospitals. Only a study in private hospitals can help to clarify this proposition.

Consistent with previous studies,[5] NEP status and parity of ≥2 were associated with a high SRB. Wong and Ho[5] showed that women who had two children of the same gender were more likely to have further pregnancies. They further analysed the relationship of sex compositions in previous pregnancies versus the index pregnancy, and concluded that women with two daughters were more likely to have male newborns.

In our study, the SRB was balanced for multiple pregnancies. Although the present study was limited by a lack of information on the proportion of multiple pregnancies after assisted reproduction, this was a reassuring finding, as applicable sex selection technology probably had not been used locally in assisted reproduction. In Hong Kong, The Council on Human Reproductive Technology is a statutory body established under Section 4 of the Human

TABLE 3. Male/female sex ratio at birth (SRB) in Hong Kong from 1981 to 2010[14]

No. of live births	Year								
	1981	1986	1991	1996	2001	2006	2008	2009	2010
Female	42 141	34 703	33 084	30 627	23 059	31 031	36 894	38 129	41 218
Male	44 610	36 917	35 197	32 664	25 160	34 595	41 928	43 966	47 366
SRB	105.8	106.4	106.4	106.7	109.1	111.5	113.6	115.3	114.9

Reproductive Technology Ordinance to regulate the provision of reproductive technology procedures. Sex selection for social reasons is prohibited under the Ordinance, except to avoid or prevent the birth of a child with a severe sex-linked genetic disease.[16]

In our study, there was an increase in the SRB to an unbalanced level (>107/100) in EPs. Although there was an increase in this ratio after having one miscarriage/TOP, this was not confirmed in the logistic multivariate regression. Sex-selective abortion is illegal in Hong Kong and many other countries. Nowadays, fetal sex can be determined non-invasively by two-dimensional[17] and three-dimensional[18] ultrasonography, and assay of cell-free fetal DNA in maternal plasma (using real-time polymerase chain reaction) after 13, 11, and 7 weeks of gestation, respectively.[19] Alternatively, karyotyping can be carried out following an invasive procedure (amniocentesis or chorionic villus sampling). However, these medical technologies should not be misused to facilitate sex-selective activities.

The consequences of high SRB should not be overlooked. Many commentators predict that it will lead to increased levels of antisocial behaviour and violence.[6] More men will remain single. This has been a consistent observation across cultures. Notably, an overwhelming percentage of violent crime is perpetrated by young, unmarried, and low-status males. Thus, an imbalance in SRB ultimately presents a threat to the long-term stability and sustainable development of Chinese society. Apart from government policy and law, public education to promote gender equality can help counter this trend. Education can be provided by family members, schools, and governments.[20] Peoples' attitudes towards this issue are also very important. Monitoring such trends is therefore warranted.

A major limitation of the present study was that the data from only one hospital, and not the whole population, were analysed. However, according to unpublished data from the Department of Health, from June to September 2012 the SRB in our hospital was 107/100, which was comparable to that in all public hospitals (108/100). Second, there was no separate analysis regarding the number of previous TOPs and miscarriages, as corresponding data for each of these conditions logged separately were not available in our database. Grouping of data for number of miscarriages and number of TOPs may mask the effect of selective abortion, if any. Third, for better understanding of the relationship between parity and sex ratio, for multiparous mothers we should have retrieved the gender of previous children.

Conclusion

Compared with 2001-2005, there was a significant increase in SRB resulting in an unbalanced level in 2006-2010. This ratio was unbalanced in both EP and NEP subjects, but to a greater extent and occurring after having only one child in the latter. Notably, the ratio was not affected by maternal age, the number of miscarriages/TOPs, and number of fetuses.

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