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Nutrition during pregnancy and early infancy in urban and rural areas of Deyang region, Southwestern China

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Summary

In the past years, China has made remarkable progress in achieving the Millennium Development Goals. However, there are still significant urban-rural disparities and regional differences in the main indicators of child nutrition, maternal and child health. Inadequate dietary intake with regard to certain macro- and micronutrients occurs among women during the reproductive period. Despite the efforts that have been made to promote breastfeeding in China since the 1990s, there is still a very low prevalence of exclusive breastfeeding during the first six months of life. Therefore, the purpose of this observational study was to assess dietary intake and identify risk factors for nutritional inadequacy in pregnant women and to assess the current situation of infant feeding practices during the postpartum hospital stay in urban and rural settings of the study area in China.

Between 2010 and 2012, cross-sectional sampling was used in two urban hospitals and five rural clinics randomly selected in the Deyang region. A total of 203 pregnant women in the third trimester and 204 pairs of mothers and newborns were recruited on the basis of informed consent during antenatal clinic sessions and in postnatal wards respectively. Semi-structured interviews on anthropometric and socio-demographic information were conducted for both the pregnant women and postpartum mothers. In addition, data on 24-h dietary recalls of pregnant women, birth outcomes and infant feeding practices of postpartum mothers were collected.

Prior to pregnancy, 26.3% of the pregnant women were found to be underweight, while only 5.1% were overweight, based on self-reported pre-pregnancy weight. The women's overall dietary energy intake during the third trimester originated excessively from fat, was low in carbohydrates, and reached the lower limits for protein. Compared to rural areas, women living in urban areas had significantly higher reference nutrient intake fulfilment levels for energy, fat, protein, vitamin A, Zn, Fe, Ca and riboflavin. The likelihood of pregnant women following certain traditional food recommendations such as avoiding beef, mutton, fish etc. was higher in rural than in urban areas.

Both the short-term (e.g. gestational weight gain) and long-term nutritional status (e.g. height) of the mothers affected the birth outcomes (e.g. type of delivery). The decision for a Caesarean

Section (CS) was not only related to medical/obstetrical issues but also nutritional and social demographic factors. The short stature of mothers, excessive gestational weight gain, larger-sized newborns, higher educational level or older ages of mothers were significantly positively related to the probability of CS.

Although almost all of the mothers started breastfeeding after childbirth, the high prevalence of CS delayed initiation of breastfeeding. Due to the widespread use of infant formula, the prevalence of exclusive breastfeeding (EBF) was only 8.0 % one week after delivery. Regardless of prelacteal feedings, almost exclusive breastfeeding (AEBF) was 34.5%. Breastfeeding initiation within two days after birth was positively associated with AEBF, whereas smaller newborns, mothers with higher education level, mothers' lack of knowledge about the importance of colostrum were negatively associated with AEBF. As most mothers lacked knowledge of the lactation physiology, higher formal education was often not related to a better knowledge of breastfeeding.

In conclusion, culturally sensitive nutrition education sessions are necessary for both urban and rural women. Special attention must be given to the nutritional status, especially of rural women, before or, at the latest, during pregnancy. Personalized nutritional guidance for expectant mothers should be based on comprehensive consideration of all aspects, such as dietary intake, place of origin (rural vs. urban), body height, and gestational weight gain etc. Better guidance for the gestational weight gain of Chinese mothers needs to be established. Although disparities between urban and rural areas exist, the situation of infant feeding is inadequate in both settings. The high prevalence of CS, the mothers' poor knowledge of the physiology of breast milk production, the mothers' lack of breastfeeding confidence, the widespread advertising of breast milk substitutes, and the changing perception of the function of breasts, may influence the unfavorable breastfeeding behavior observed in the study area. In order to prevent CS and to promote breastfeeding, education about the complications and disadvantages of CS especially among mothers with higher education, older childbearing age, and primiparas needs to be strengthened. Supporting adequate maternal nutrition during the reproductive period and creating a good breastfeeding environment requires the efforts of the whole society.

Zusammenfassung

In den letzten Jahren konnte China bemerkenswerte Fortschritte bei der Verwirklichung der Millenniums-Entwicklungsziele erreichen. Es gibt jedoch immer noch erhebliche Unterschiede zwischen Stadt und Land, sowie regionale Unterschiede bei der Erfüllung der Hauptindikatoren für kindliche Ernährung, oder der Gesundheit von Mutter und Kind. Bei Frauen im gebärfähigen Alter liegt eine unzureichende Versorgung mit Makro- und Mikronährstoffen häufig vor. Trotz der Bemühungen die seit den 1990er Jahren in China unternommen wurden, um das Stillen zu fördern, ist die Prävalenz des ausschließlichen Stillens in den ersten sechs Lebensmonaten sehr gering. Ziel dieser Beobachtungsstudie war es, die Nahrungsaufnahme schwangerer Frauen zu erheben als auch Risikofaktoren für eine unzureichende Ernährung zu ermitteln, sowie die aktuelle Situation der Säuglingsernährungspraktiken während des Krankenhausaufenthalts nach der Geburt in städtischen und ländlichen Regionen innerhalb des Untersuchungsgebietes zu bewerten.

Zwischen 2010 und 2012 wurden in zwei städtischen Krankenhäusern und fünf zufällig ausgewählten ländlichen Kliniken in der Region Deyang Querschnittsproben erhoben. Insgesamt konnten 203 schwangere Frauen im dritten Trimester und 204 Mutter-Kind Paare auf der Grundlage einer Einverständniserklärung während vorgeburtlicher Untersuchungen in Kliniken bzw. auf postnatalen Stationen rekrutiert werden. Strukturierte Interviews zu soziodemografischen Fragestellungen und anthropometrische Erhebungen wurden sowohl für schwangere Frauen als auch für Mütter nach der Entbindung durchgeführt. Darüber hinaus wurden 24-Stunden-Ernährungsprotokolle bei schwangeren Frauen erhoben, während Geburtsergebnisse als auch Säuglingsernährungspraktiken postnatal bei Wöchnerinnen erfragt werden konnten.

Vor der Schwangerschaft waren 26,3% der Frauen untergewichtig, aber nur 5,1% übergewichtig, basierend auf selbstberichteten Gewichtsdaten. Die Nahrungsenergie der schwangeren Frauen im 3 Trimester stammte übermäßig aus Fett, war kohlenhydratarm und erreichte die untere Grenze des Proteinreferenzwertes. Im Vergleich zu Frauen aus ländlichen Gebieten erreichten die in der

Stadt Deyang lebenden Frauen eine signifikant höhere Erfüllung der Nährstoffreferenzwerte in Hinblick auf Energie, Fett, Protein, Vitamin A, Zn, Fe, Ca und Riboflavin. Die Wahrscheinlichkeit, dass schwangere Frauen bestimmte traditionelle Ernährungsempfehlungen, wie die Vermeidung von Rindfleisch, Hammel, Fisch usw. befolgen, war in ländlichen Gebieten höher als in der Stadt.

Sowohl der kurzfristige (z. B. Gewichtszunahme während der Schwangerschaft) als auch der langfristige Ernährungsstatus (z. B. Größe) der Mütter beeinflusste die Geburtsergebnisse (z. B. Art der Entbindung). Die Entscheidung für einen Kaiserschnitt stand nicht nur in Zusammenhang mit medizinischen/geburtshilflichen Fragen, sondern auch mit ernährungsbedingten und soziodemografischen Faktoren. So stand ein verkürztes Längenwachstum der Mutter, eine übermäßige Gewichtszunahme während der Schwangerschaft, die Größe des Neugeborenen, sowie ein höheres Bildungsniveau oder zunehmendes Alter der Mutter in signifikant positiven Zusammenhang mit der Wahrscheinlichkeit für eine Kaiserschnittentbindung.

Obwohl fast alle Mütter nach der Geburt mit dem Stillen begannen, verzögerte die hohe Kaiserschnitt-Prävalenz den Beginn des Stillens. Aufgrund der weit verbreiteten Verwendung von Muttermilchersatzprodukten betrug die Prävalenz des ausschließlichen Stillens eine Woche nach der Entbindung nur 8,0%. Unabhängig von der prelaktalen Nahrungszufuhr, betrug das fast ausschließliche Stillen 34,5%. Der Beginn der Laktation innerhalb der ersten zwei Tage nach der Geburt war positiv mit fast ausschließlichem Stillen assoziiert, während kleinere Neugeborene, Mütter mit höherem Bildungsniveau und Mütter, denen das Wissen über die Bedeutung von Kolostrum fehlte, negativ mit fast ausschließlichem Stillen assoziiert waren. Da die meisten Mütter keine Kenntnisse über die Laktationsphysiologie hatten, war eine höhere formale Bildung meist nicht mit einer besseren Kenntnis des Stillens verbunden.

Zusammenfassend ist festzuhalten, dass sowohl für Frauen aus städtischen als auch ländlichen Gebieten eine kulturell sensible Ernährungsberatung erforderlich ist. Besondere Aufmerksamkeit muss dem Ernährungszustand, insbesondere bei Frauen auf dem Land, vor oder spätestens während der Schwangerschaft gewidmet werden. Personalisierte Ernährungsberatung für werdende Mütter sollte auf einer umfassenden Berücksichtigung aller Aspekte wie

Nahrungsaufnahme, Herkunftsort (ländlich oder städtisch), Körpergröße und Gewichtszunahme während der Schwangerschaft basieren. Eine bessere Beratung hinsichtlich der Gewichtszunahme während der Schwangerschaft chinesischer Mütter sollte eingeführt werden. Obwohl sich Unterschiede zwischen städtischen und ländlichen Gebieten aufzeigten, ist die Situation der Säuglingsernährung in beiden Regionen unzureichend. Die hohe Kaiserschnitt-Prävalenz, das mangelnde Wissen der Mütter über die Physiologie der Muttermilchproduktion, unzureichendes Vertrauen der Mütter in das Stillen, die weit verbreitete Werbung für Muttermilchersatzprodukte und die veränderte Wahrnehmung der Funktion von Brüsten können zu ungünstigen Stillpraktiken führen. Um medizinisch nicht begründete Kaiserschnitte zu vermeiden und das Stillen zu fördern, muss die Aufklärung über die Komplikationen und langfristigen Nachteile von Kaiserschnittgeburten, insbesondere bei gebildeteren Müttern, und Frauen in höherem gebärfähigen Alter als auch bei Erstgebärenden, verstärkt werden. Die Verbesserung der mütterlichen Ernährung während der reproduktiven Phase und die Schaffung eines guten Stillumfeldes erfordert die Anstrengungen der gesamten Gesellschaft.

Stuttgart, 23.02.2021	Prof. Dr. Regina Birner
Place, Date	Signature of supervisor

Stuttgart, 23.02.2021	PD. Dr. Veronika Scherbaum
Place, Date	Signature of supervisor

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Abbreviations

AEBF	Almost exclusive breastfeeding
AI	Adequate intake
ALA	α-linolenic acid
AMDRs	Acceptable macronutrient distribution ranges
BMI	Body mass index
BMS	Breast milk substitutes
Ca	Calcium
CSs	Caesarean section
DRIs	Dietary reference intakes
EBF	Exclusive breastfeeding
FAO	Food and Agriculture Organization of the United Nations
Fe	Iron
FGDs	Focus group discussions
FNS	Food and nutrition security
GWG	Gestational weight gain
Hb	Hemoglobin
INFSC	Institute of nutrition and food safety China
IOM	Institute of Medicine
LA	Linoleic acid
LBW	Low birth weight
Mg	Magnesium
MUAC	Mid-upper arm circumference
MUFA	Monounsaturated fats
NMMSS	National Maternal Mortality Surveillance System in China
NNHS	National Nutrition and Health Survey (China)
PAL	Physical activity level
RCMS	Rural cooperative medical scheme

RNI	Recommended nutrient intake
RtF	Right to food
SD	Standard deviation
SFA	Saturated fats
TV	Television
UNICEF	United Nations International Children's Emergency Fund
VD	Vaginal delivery
WHO	World Health Organization
Zn	Zinc

Chapter 1

General Introduction

1 General Introduction

Whether it is in the Millennium Development Goals (MDGs) before 2015 or the current Sustainable Development Goals (SDGs) by the United Nations, improving maternal health, reducing child mortality and eliminating malnutrition were/are set as clear development goals [1, 2]. Food and nutrition security (FNS), especially during pregnancy, lactation and early childhood, is of utmost importance for both maternal and child health and has long-term consequences for the next generation.

Despite thousands of food and nutrition interventions all over the world, malnutrition is still associated with 45% of under 5 mortality [3] and with poor fetal development and high risks of pregnancy complications in developing areas [4, 5]. Worldwide, maternal and child malnutrition accounts for more than 10% of the global burden of disease nowadays [4]. WHO indicated that the policies and programs on nutrition in different countries "are often inadequate in face of the complexity of the challenges of maternal, infant and young child nutrition and do not produce the expected impact" [5]. More effective programs based on good understandings of particular social contexts are urgently required.

By 2015, China had made remarkable progress in achieving MDGs. Overall, the 4 goals in the reduction of "hunger and malnutrition, the under-five mortality rate, the maternal mortality ratio", and achieving "universal access to reproductive health" were already or basically met between 1990 and 2015 [6]. However, China still faces certain challenges in these areas. The pressure to achieve food security for 1.4 billion people is enormous. At the same time, there are significant urban-rural disparities and regional differences in the main indicators of child nutrition and maternal and child health. The maternal and child health system cannot effectively cover all marginalized and vulnerable groups. As the health needs of mothers and children are not fully met at different stages of life, the quality of health services needs to be improved [6]. These problems illustrate that a short-term and rapid achievement of numerical quantitative goals may not necessarily solve regional problems fundamentally, so there are still many details worth discussing.

Scope of this study

In order to summarize the past experience of successfully implementing MDGs, so as to better achieve SDGs and to address the food and nutrition problems fundamentally, rather than seeking short-term solutions (i.e., food aid), the leading question of this study has become: "*What food belief systems and feeding /consumption practices lead to improved FNS for maternal & infant health in China?*" This study is composed of two major interactive parts: FNS for women during pregnancy and FNS for infants (see Figure 1.3).

The main aims are to understand the food and nutritional habits of pregnant women, the socio-cultural reasons for the decline in breastfeeding, as well as the reasons behind the rise in infant formula use. Finally, recommendations for food and nutritional interventions, education and policymaking will be developed on the basis of relevant findings of this study.

1.1 Background

1.1.1 Definition

During pregnancy, the maternal diet provides energy and nutrients for both the mother and the fetus. FNS for a pregnant woman means having an affordable, acceptable and healthy dietary intake that ensures her own health status as well as a good birth outcome, i.e., a healthy infant. Thereafter, optimal nutritional support of infants in the first year of life is also essential to attain normal trajectories of growth and development [7]. For infants, who cannot take care of themselves, appropriate feeding methods/food types adopted and implemented by their parents are the key means of achieving their FNS. Ideally, this means exclusive breastfeeding in the first six months of life and receiving nutritionally adequate and safe complementary foods, while continuing to breastfeed for up to two years or more [8].

In the contemporary meaning of FNS, the food supply is no longer the only or major determinant of malnutrition, but it is, rather, the lack of purchasing power, ignorance about nutrition, and subjective tastes or preferences that prevent some households and individuals from securing adequate food [9, 10]. Consistent with the situation in China, in some areas, rapid economic

growth is not always followed by improved nutritional status [11]. Nutritional knowledge and attitudes associated with socio-cultural factors have a significant influence on the food choices and feeding practices of pregnant/postpartum women and caretakers of infants.

1.1.2 Food and nutrition aspects from pregnancy to the neonatal period

Pregnancy, puerperium and the neonatal period are special physiological periods with a high mortality rate, and nutrition plays a central role in the prevention of both maternal mortality and under-5 mortality [12]. There are different meanings, targeted goals, and control factors of nutrition science during these three different periods.

Compared with non-pregnant women, extra energy and nutrients are essential for the growth of the pregnant woman's own body tissues and the development of the fetus [13]. Normally, the extra nutritional requirements during pregnancy are determined according to the different stages of pregnancy, pre-pregnancy BMI (body mass index), and the level of physical activity of the pregnant woman [14]. Whether a pregnant woman's nutritional needs can be met is largely affected by her total food intake, choice of food types, cooking methods and individual genetic factors. Furthermore, the food choices and cooking methods will be affected by factors, such as the family's economic situation, local culture, and food availability [15].

Nutritional status during pregnancy is associated with birth outcomes. If malnutrition occurs during pregnancy, the chance of a miscarriage, fetal growth restriction, birth defects and low-birth-weight infants will increase greatly [16]. While too much food intake during pregnancy may lead to excessive gestational weight gain, which is associated with the risk of fetal macrosomia and dystocia, resulting in a high chance of Caesarean section.

For newborns, the most important source of nutrition is breast milk. WHO has released "Ten Steps to Successful Breastfeeding" to promote breastfeeding in baby-friendly hospitals [17]. However, the success of the initiation of breastfeeding and exclusive breastfeeding might be affected - directly or indirectly - by nutritional factors, for example, the type of Caesarean section, induced by excessive weight gain during the mother's pregnancy, delays the time of breastfeeding

initiation. Meanwhile, it is difficult to exclusively breastfeed a newborn while his mother is severely malnourished. Because severe malnutrition could cause inadequate breast milk secretion and insufficient nutrient composition of a mother's breast milk, which cannot meet the needs of an infant and results in growth retardation [16]. Eventually, the decline in breastfeeding and rise in infant formula increases risks of childhood obesity and food safety.

From the perspective of a lactating mother, good nutritional status is the basis for both promoting postpartum rehabilitation and ensuring breast milk secretion. If nutrition is insufficient during this period, it will cause excessive consumption of a mother's own nutritional reserves and can lead to the occurrence of postpartum chronic diseases. On the contrary, if a mother eats too much after childbirth, the fat accumulated during pregnancy cannot be fully utilized for breast milk production, thereby increasing the risk of the mother becoming overweight and obese.

Moreover, the intake of chemical residues (pesticides, food additives, hormones, antibiotics etc.) during pregnancy can have effects on fetal development and long-term influences on their later growth [18, 19]. Furthermore, small children are more vulnerable to toxins than adults [20, 21]. Their exposure to chemicals at critical stages in their physical and cognitive development may have severe long-term consequences for their health [22-24]. Pregnant women and lactating mothers should pay special attention to food safety. However, in China's social and economic environment, how much attention women paid to food safety, and how to ensure it requires further research.

1.1.3 Sustainable healthy diet

A healthy and proper diet is the basis of good nutrition [25]. The concept of a "sustainable healthy diet" are dietary patterns that promote all dimensions of an individual's health and well-being; have low environmental pressure and impact; are accessible, affordable, safe and equitable; and are culturally acceptable [26]. While being consistent with the SDGs of the United Nations, the sustainable healthy diet sets out practical methods for achieving maternal and infant nutritional security (see Figure 1.1).

Figure 1. 1 Guiding Principles for a Sustainable Healthy Diet [26]

From the perspective of pregnant/lactating women, a sustainable healthy diet means “a great variety of unprocessed food”, “balanced across food groups”, “adequate in energy and nutrients”, “contain no pathogens, toxins”; while it also means “early initiation of breastfeeding”, “exclusive breastfeeding until six months of age”, “continued breastfeeding until 2 years and beyond” etc. for infants (see Figure 1.1).

1.2 Problem statement

China has achieved several health-related SDG targets, such as neonatal and under-5 mortality rates, maternal mortality ratios, reducing wasting and stunting for children [27]. Although the coverage of medical services for women and children is already very high (see Table 1.1), the Chinese government has clarified future challenges and development goals in “Healthy China 2030” [28] and “National Nutrition Plan 2017-2030” [29]. In the field of maternal and infant nutrition, there are still many problems.

Table 1. 1 Coverage of maternity and child health care in China (2018) [30, 31]

	Prenatal examination	Postnatal visit	Hospital delivery	System management of children under 3 years of age
Rate	96.6%	93.8%	99.9%	91.2%

1.2.1 Maternal nutrition in China

Before this study, there was a high prevalence of maternal anemia (Hb<110g/L) among women of childbearing age, with an average rate of 20.6% [32], while some progress was made until 2013 (maternal anemia: 15.0% and anemia during pregnancy: 17.2%) [33]. In addition, nutritional deficiencies (Ca, Fe, Zinc, Vitamin A, folic acid, protein etc.) and inadequate energy intake are still common [32-36]. In some underdeveloped rural areas, the situation is even worse, as pregnant women there have low dietary intake for most nutrients, especially for nutrients such as iron, zinc and folic acid which are crucial in pregnancy [37, 38].

Actually, most pregnant Chinese women have positive attitudes toward increasing food intake during pregnancy [39-42], but there are many misunderstandings about how to improve nutritional status. For instance, a number of pregnant women still have a limited diversity of food [41], food choices are mainly based on personal tastes/preferences or food habits [40, 42], or unbalanced diet (too much fat) [43]. And many pregnant women wrongly believe a healthy diet means eating as much as possible [39]; fine grains are more nutritious than whole grains [39]; their own body weight can increase unlimitedly to supply nutrients to the fetus [40]. These habits/beliefs can cause inadequate food intake for them. Besides pregnancy, the postpartum period is also a very special phase in the life of women as they recover from childbirth. But maternal nutrition during this period is often ignored by people or even by lactating women themselves, as some "modern" women are anxious to lose weight as soon as possible after childbirth. This can lead to insufficiency in nutrient and energy intake to meet the health and lactation needs of postpartum women.

Normally, pregnant/lactating women get dietary advice through the hospital service staff, the experience of their parents or friends, publications, advertisements on TV, internet, smartphone apps etc.[39, 40, 44, 45]. However, depending on their educational level, resources for getting dietary advice and their awareness of the need to acquire nutritional knowledge etc., the quality of their dietary behavior varies widely [42, 46]. Moreover, in accordance with traditional Chinese culture, both pregnant and postpartum women are advised to follow a specific set of food choices [44, 47, 48]. According to traditional Chinese medicine theory, the fetus is considered to be pure "Yang". Things with "Yin" quality, such as cold food, may be harmful to the fetus and cause miscarriage; while breastfeeding mothers eating cold food is not conducive to their own postpartum recovery, and may cause diarrhea in the baby [47, 48]. Available studies indicate that some of these traditional food taboos are not reasonable or are even harmful to women's health [49] for example, avoiding foods such as fruits, vegetables which are considered to be "cold". It is true that China's fertility modernization has more or less weakened the influence of traditional food taboos in urban areas [48], but the influence of traditional culture in underdeveloped rural areas is still strong. The Sichuan area is famous for its rich variety of food. Whether the traditional reproductive culture of the region may have a negative impact on maternal nutrition remains to

be further explored.

1.2.2 Infant feeding in China

In China, not all parents are aware of the impact of feeding mode in infancy. Before the initiation of this study, as shown in one study by Ma LP et al., only 29.2% of caregivers of young children considered the feeding mode in infancy to be of significant importance for children's future development; while 31.8% of the parents thought there was only a small or no effect of the type of feeding during early childhood [50]. Normally, new parents could learn about infant feeding from hospital staff, publications, grandparents, friends, internet and TV etc.[44, 51, 52]; grandparents' recommendations play a more important role in rural than in urban areas [53]. The extent of the new parents' feeding knowledge varies according to the different sources. The research of Chen JF et al. showed that only 4.2% (urban 8.6%; rural 1.5%) of new parents were completely aware of the scientific recommendations regarding infant feeding [54]. In general, rural people lacked health knowledge and were greatly influenced by traditional feeding practices [55].

Breastfeeding

Breastfeeding, often discussed in the context of women and children's health, has several benefits in the short and the long term (see Table 1.2). Especially for the most vulnerable population, breast milk is the only and valuable resource to improve food and nutrition security for their babies. Also, the economic value of breast milk is much higher than that of infant formula. Furthermore, compared with bottle-feeding, breastfeeding costs next to nothing. In other words, even in very poor families, food and nutrition security for infants (<6months) can be achieved through improved breastfeeding practices.

In China, as in several other countries "in transition", infant feeding practice is often not in line with the international recommendations of WHO. Only 21% of Chinese mothers practiced exclusive breastfeeding in the first 6 months of their children's lives between 2013 and 2018 [31]. The data of national prevalence of continued breastfeeding up to 2 years was not available in

recent years, however, some regional studies showed that the situation is not positive [56, 57]. Although there is a growing number of Baby-Friendly Hospitals in China [58, 59], the prevalence of breastfeeding is decreasing.

Table 1. 2 Benefits of breastfeeding

	Short term	Long term
Child's health	• appropriate quality and quantity of breast milk meeting infant requirements • stress reduction and the concomitant effects on physiology (reduced energy requirements, more stable temperature, better blood sugar levels) [60] • immunological benefits of colostrum and mature mother's milk [61] • lower morbidity and mortality by contrast to bottle fed infants[62]	• improved school achievement [63] • Reduced risk for developing overweight/obesity [64] • Lower rates of diabetes type 2[62], hypercholesterolemia and hypertension in later life[65]
Woman's health	• reduced blood loss after delivery[66] • lower rates of postpartum depression[62] • Faster return to pre-pregnancy weight[67]	• improved calcium metabolism[68] • changes in HDL cholesterol persisting after weaning [69] • improved immune function [70] • reduced prevalence of endometrial-, ovarian-, and breast cancer[62] • lower rates of diabetes type 2 and coronary heart diseases[62]

Reasons for the decline of breastfeeding in China

Most Chinese mothers/parents are not fully aware of the benefits and the appropriate duration of breastfeeding [44, 50, 51]. And even mothers aware of the importance of breastfeeding, are often not successful breastfeeding for various reasons. In addition to more rare medical reasons (i.e. maternal or child illness, breast problems), there are a lot of socio-cultural reasons responsible for early weaning (≤ 4 months) and replacement of breast milk by breast milk substitutes (BMS) in China. (see Table 1.3)

Nowadays, women play a more and more important role in "modern" society. Breastfeeding,

which requires considerable attention from the mothers and close proximity of mothers and babies, is perceived to tie women down socially and to make fathers feel left out [71, 72]. Feeding assistance from others and perceived convenience/comfort could motivate the mothers to choose formula feeding. Literature reviews on the decision-making process of breastfeeding, show that knowledge alone does not ensure any particular decision [72]. The lactating woman's social network must be given more attention. Deep-rooted social reasons (i.e. culture, policies etc.) behind the risk factors responsible for the decline of breastfeeding in China, need to be explored and further analyzed [72-74].

At the same time, there are differences between rural and urban areas; breastfeeding prevalence is higher in rural areas than in urban areas in China [55, 75]. Nevertheless, rural women have poorer knowledge about infant feeding practices than urban women, as more of them think bottle-feeding is even better than breastfeeding [53]. On the surface, although rural women practice better breastfeeding than urban women, it is not because of a better understanding of breastfeeding but due to their lower economic capacity (as infant formulas are not affordable for them). For vulnerable rural women, breast milk is the best and only source of ensuring good nutrition for their babies (<6months). Feasible methods to protect breastfeeding are particularly important in these areas.

Table 1. 3 Socio-cultural reasons for the decline of breastfeeding in China

Reason
• increasingly hard-working conditions [72, 76]
• lack of adequate maternity leave [77]
• inappropriate traditional infant feeding recommendations [55, 77]
• extremely high Caesarean section — at national level > 50% [53, 77-80]
• aggressive advertising for baby milk/food [81]
• inefficient support from family members [44]

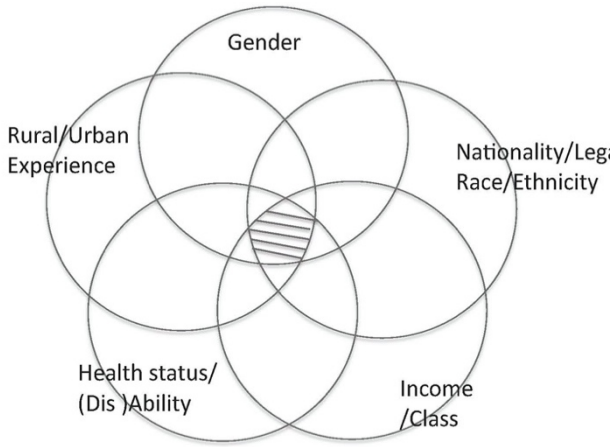
Compared with 10 years ago, as Chinese policymakers recognized the benefits and declining situation of breastfeeding, the promotion of breastfeeding in China has been set as one of the

major goals of child nutrition [29]. However, based on the complex factors, in-depth understandings of the social, cultural, economic, and nutritional difficulties faced by local mothers in the process of breastfeeding is the basis for achieving this goal.

1.2.3 Vulnerability of target groups

The target groups of this study are pregnant women and postpartum mothers and their newborns in rural and urban areas of the Deyang region in China. According to intersecting relations of social inequalities, women of reproductive age/ (during pregnancy and lactation), especially those from rural areas, form one of the most vulnerable groups of people. These women are more likely to suffer from dietary imbalance and nutrient deficiencies [82].

Figure 1. 2 Intersecting Vulnerabilities: An approach to understanding specific power inequalities faced by rural minority women



Adapted from Anne C. Bellows (2010, University of Hohenheim), based on the theory of intersectionality by Kimberlé Crenshaw [83]

1.2.4 Maternal lifestyles and infant feeding

People's different social situations and household contexts together with lifestyle factors (i.e. general values, work, leisure, consumption, health etc.) shape their nutritional choices [84, 85]. Maternal lifestyles, the way in which women live, eat or exercise during pregnancy and lactation can have positive or adverse impacts on their health status and that of their babies [86]. Maternal smoking, for instance, or longer maternal sleep duration (≥ 8 h/d), as well as food habits (i.e. skipping breakfast) are associated with overweight in young children [87, 88]. Smoking and oral

contraceptive use influence the newborn's level of zinc, copper and cadmium [89]. Moreover, a mother's attitude toward childbirth could affect her own concerns about her baby and her time spent with it [90].

Further studies on lifestyles of rural and urban women during pregnancy and their children's early years are necessary. They would be helpful in ascertaining how maternal lifestyles influence infant feeding practices and consequently contribute to improved maternal and infant's nutritional status.

1.2.5 Food safety and sustainability

As a result of the frequent food safety issues in China, more and more parents are aware of the importance of food quality. Breast milk is the best source of nutrition for infants, but indicative of exposure of lactating women to residues in their diets and from other environmental sources, contamination of human milk is widespread all over the world [91-93]. Bioaccumulation results in increased exposure to these chemicals for breastfeeding infants (who are at the top of the food chain) and compromises (though does not negate) the benefits of breastfeeding [21, 94]. The extent to which food contributes to overall exposure depends partly on a mother's long-term individual dietary habits and food choices before/during pregnancy and lactation period [92, 95, 96]. In addition, safety accidents with infant formula milk powder have occurred frequently in China. In September 2008, a very serious food safety crisis involving the contamination of breast milk substitutes (BMS) with melamine - broke out nationwide. More than 51 900 infants and children were hospitalized for urinary problems, and 6 infants died [97].

From the perspective of SDG [1, 26]， there is no doubt that breast milk is the best baby food. Compared with BMS, breast milk not only reduces the consumption of natural resources but also avoids environmental pollution caused by the production of BMS. Breastfeeding can ensure the nutrition of infants while achieving a virtuous cycle of sustainable development. However, whether and how Chinese mothers consider food safety and sustainability issues when choosing food for themselves and their children, so as to make better choices that are environmentally friendly (such as organic food, breast milk etc.), is unknown.

1.3 Relevance of this study

Health recommendations and scientific evidence may not always successfully motivate appropriate practice, because the way people eat is governed as much as, if not more so, by habits, routines, and limitations of the local environment than by deliberate and rational choice [15, 85, 98-100]. A good understanding of traditional food habits, as well as sources for acquiring dietary knowledge, is important to ascertain the reasons for food and nutrition insecurity in particular social environments. It is rare to find studies linking nutrition and socially oriented research together in China. Nutrition based research has mainly shown dietary deficiencies of pregnant women and inappropriate feeding strategies for infants, but not the social conditions in which food/feeding choices are made. More practical ways to help targeted groups (pregnant/ postpartum women and infants) should be explored to enable caretakers to reach and engage with families and discover acceptable models for behavioral changes (e.g. improving people's awareness about nutrition and, at the same time, access, acceptability and affordability of foods) [15, 101]. Fully understanding the decision-making process and influencing factors is important for policy making, development of food marketing/food systems and modification of peoples' uninformed/problematic food and feeding habits [85].

Currently, child overweight/obesity and improving breastfeeding are the two major problems in the field of child nutrition in China [27]. The importance of breastfeeding has been described above. At the same time, breastfeeding is not only the best feeding mode to prevent infant overweight, but also has a long-term effect on the prevention of childhood overweight/obesity [64]. Propaganda to promote breastfeeding has been carried out for many years in China, but the prevalence of breastfeeding has not increased. This study explored the underlying reasons for the decline of breastfeeding in the study area, with respect to mothers' needs for professional support, their initiation of breastfeeding (related to Caesarean section, worries about neonatal hypoglycemia, the culture of prelacteal feeding etc.), and mothers' knowledge of breastfeeding. The aim was to provide more detailed basic information for breastfeeding promotion in order to facilitate targeted interventions.

Both government reports and regional studies indicate urban-rural disparities of maternal and

child health in China. But there are few in-depth studies to analyze the causes of the differences between urban and rural areas. When designing this study, full consideration was given to including samples from both urban and rural areas. The result of this research is conducive to developing different strategies for urban and rural maternal and child health care services.

Picture 1. 1 Farmer's market in rural area of the study area

In China, maternal and infant nutrition has attracted more and more attention. Due to the different cognitions and socio-economic conditions, the individual nutritional status of mothers varies greatly. Many mothers need professional nutrition guidance. However, obstetricians and pediatricians usually simply make recommendations, such as what to eat more of and what to eat less of, without a specific diet management plan. In other words, the service provided by general medical institutions cannot meet the individualized nutritional needs of mothers. The findings of this study, such as the imbalance of urban and rural diets, are helpful for doctors in formulating

precise nutritional guidance and intervention strategies for different population groups.

Caesarean section was found to be one of the factors hindering breastfeeding practices in this study. Except for the Caesarean section with clear medical indicators, people think that unnecessary Caesarean section is a mother's choice. Merely mothers fully understand the risks and disadvantages of Caesarean section and the psychological constructions about natural delivery before childbirth, the high prevalence of Caesarean section can be prevented. The actual situation is not as expected. In addition to cognitive factors, this study found that both the short-term (during the reproductive stage) and long-term nutritional status of the mother can affect the type of delivery. From the perspective of short-term nutrition, strict weight control during pregnancy and balanced nutrition can help control the size of the fetus, thereby reducing the risk of Caesarean section. From the perspective of long-term nutrition, a quarter of local mothers belonged to the short stature (<155cm), which is related to the high probability for a Caesarean section. As long as China has not established comprehensive guidelines for weight gain during pregnancy, controlling local mothers' weight gain during pregnancy needs to fully consider their height in addition to pre-pregnancy BMI.

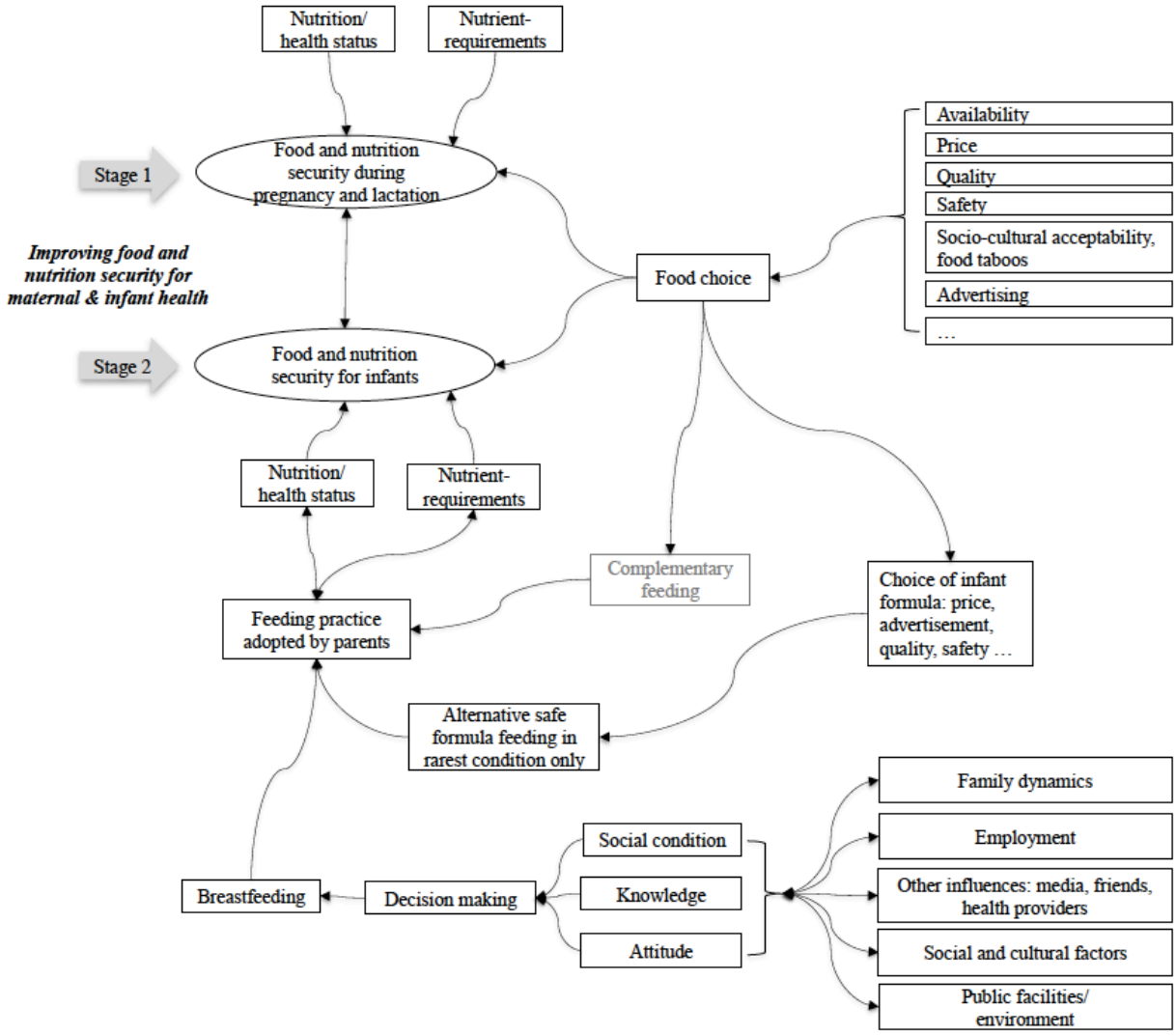
1.4 Conceptual framework

This study was composed of two interactive parts, maternal FNS, and infant FNS. An individual's FNS is affected by one's own nutrition and health status, nutritional requirements at different growth stages, and food choices. FNS for a pregnant woman means having an affordable, acceptable and healthy dietary intake that ensures her own health status as well as a good birth outcome, i.e. a healthy infant. For infants, who cannot take care of themselves, appropriate feeding methods/food types adopted and implemented by their parents are the key means of achieving their FNS.

Based on the theory of the psychology of food choice, reviewing the food/feeding mode choice processes is the first step in planning dietary and behavior change modifications [85]. Therefore, the important factors involved in the food/feeding mode choice (see Figure 1.3)[71], the perceptions of the mothers/parents, and their experiences in shaping current food choices and

feeding mode were analyzed in this research.

Figure 1. 3 Improving food and nutrition security for maternal & child health



Designed by Haoyue Gao in 2009 on the basis of teaching materials of the "Global Nutrition, Marketing of Organic Food, Rural Development etc. ----Master Courses of Organic Food Chain Management" at the University of Hohenheim

1.5 Hypothesis

- Dietary characteristics of pregnant women in the study area can largely meet the recommended nutritional intake values during pregnancy, and the diets of urban pregnant women are healthier than those of rural pregnant women.

- Compared to rural mothers, urban mothers, who are better educated and fully aware of the importance of breastfeeding, are more likely to breastfeed exclusively.

1.6 Objectives

-To assess the dietary knowledge, practice, nutritional/therapeutic value of recommended foods for pregnant women, and their health outcomes.

-To explore the social and cultural reasons for the decline in breastfeeding and make practical recommendations for the promotion of breastfeeding in the study area.

-To explore nutritional factors associated with birth outcomes and feeding practice in the study area.

1.7 General Methodology

1.7.1 Location of study area

Deyang City is located in the northeast of Chengdu Plain in Sichuan province (southwestern China). It covers an area of 5 911 km^2 and has a population of 3.9 million [102]. Jingyang District is one of the 6 districts of Deyang City, it is located in the middle of Deyang region.

Jingyang District (648 km^2) is composed of five road districts in urban area, eleven larger communities (Bolong, Xiaoquan, Dexin, Huangxu, Yangjia, Xiaogan, Shuangdong, Tianyuan, Bajiaojin, Hexin, Xinzhong) and a community (Jingyangxiang) in a rural area (12 rural communities in total) [103, 104]. In 2009 during the planning stage of this study, the number of newborns was 4671 in Jingyang District (unpublished data), about 3000 of them were from rural areas. 5 rural larger communities were selected through methods of simple random sampling. They are Tianyuan, Xiaoquan, Hexin, Yangjia and Shuangdong.

For more information about the study area, see chapter 2.2.1, chapter 3.2.2, and chapter 4.2.1.

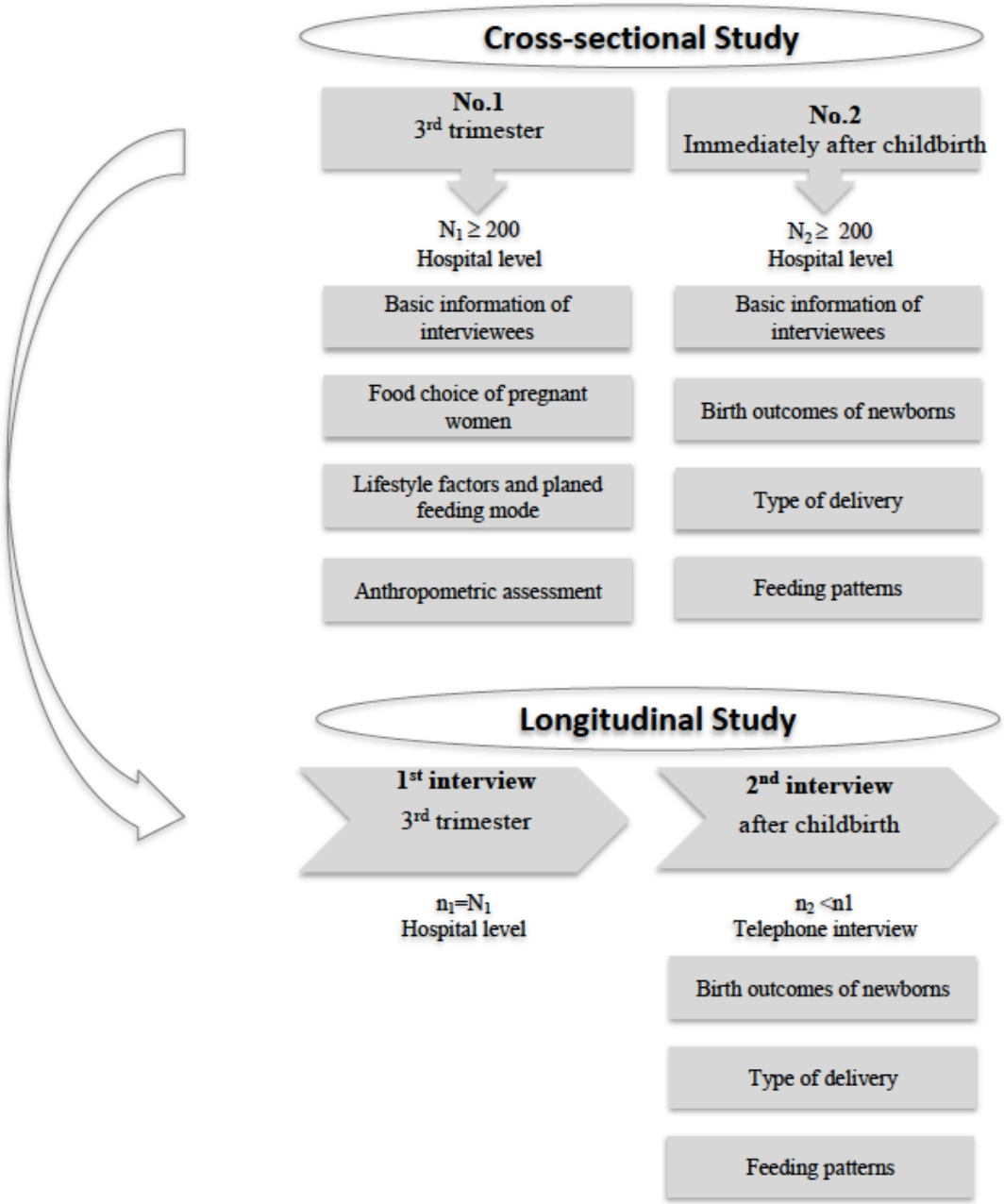
Figure 1. 4 Map of randomly selected rural hospitals in the Jingyang district （modified according to Baidu map）

1.7.2 Study population

A total of 203 pregnant women in the third trimester, aged 19–42, were recruited with informed consent during antenatal clinic sessions. Finally, 201 pregnant women were analyzed (62.7% in urban, 37.3% in rural areas); two were excluded because their residences were missing.

And 204 mothers with newborns were recruited consecutively on postnatal wards on the basis of informed consent. Interviews were conducted before discharge using a structured questionnaire. In addition, in order to explore the social/cultural reasons influencing mothers' feeding practices, five focus group discussions (FGDs) with three to six local breastfeeding mothers and their infants were held. On the basis of informed consent, a total of 21 mothers were randomly recruited during their monthly child health care visits at one urban hospital.

Figure 1. 5 Flow chart of field activities



1.7.3 Study design

A cross-sectional study was carried out in the Deyang region from the year 2010 to 2012 (Figure 1.5). It was conducted in the obstetrics and pediatrics departments of the rural and urban hospitals (2 hospitals in the city and 5 public health clinics in the countryside). About 200 pregnant women were approached during their antenatal care in the 3rd trimester. Simultaneously, about 200

mothers with newborns were recruited from the respective clinics during child health care. The purpose of this part of the study was to investigate the lifestyle patterns, nutritional status, dietary characteristics and the planned/actual infant feeding mode.

Longitudinal/cohort research, designed as a supplementary study to the cross-sectional assessment, consists of hospital/telephone interviews during the postpartum period, and home visits during the breastfeeding period. Some of the pregnant women in the cross-sectional study were followed up to assess their birth outcomes and actual feeding practices. During home visits, information about the duration of exclusive breastfeeding, the socio/cultural issues involved in the decision on bottle feeding and/or returning to the workplace etc., was collected.

1.7.4 Calculation of sample size

Based on the simple random sampling [105, 106], initial sample size was calculated by:

$$n_1 = \frac{Z^2 P(1-P)}{e^2} = \frac{1.96^2 * 0.5 * (1-0.5)}{0.10^2} = 96$$

Assumption:
Z= 1.96 (confidence level 95%),
e= 0.10 (sampling error 10%),
P= 0.5 (when P=0.5, the population variance will get the maximum value)

Initial sample size n_1 adjusted by correction factor of finite population N'= 4671 (number of newborns in Jingyang district in 2009, Deyang Statistic, 2010):

$$n_2 = \frac{n_1 N'}{N' + n_1} = \frac{96 * 4671}{4671 + 96} = 94$$

n_2 corrected by response rate r= 0.6 (assumption):

$$N = \frac{n_2}{r} = \frac{94}{0.6} = 157$$

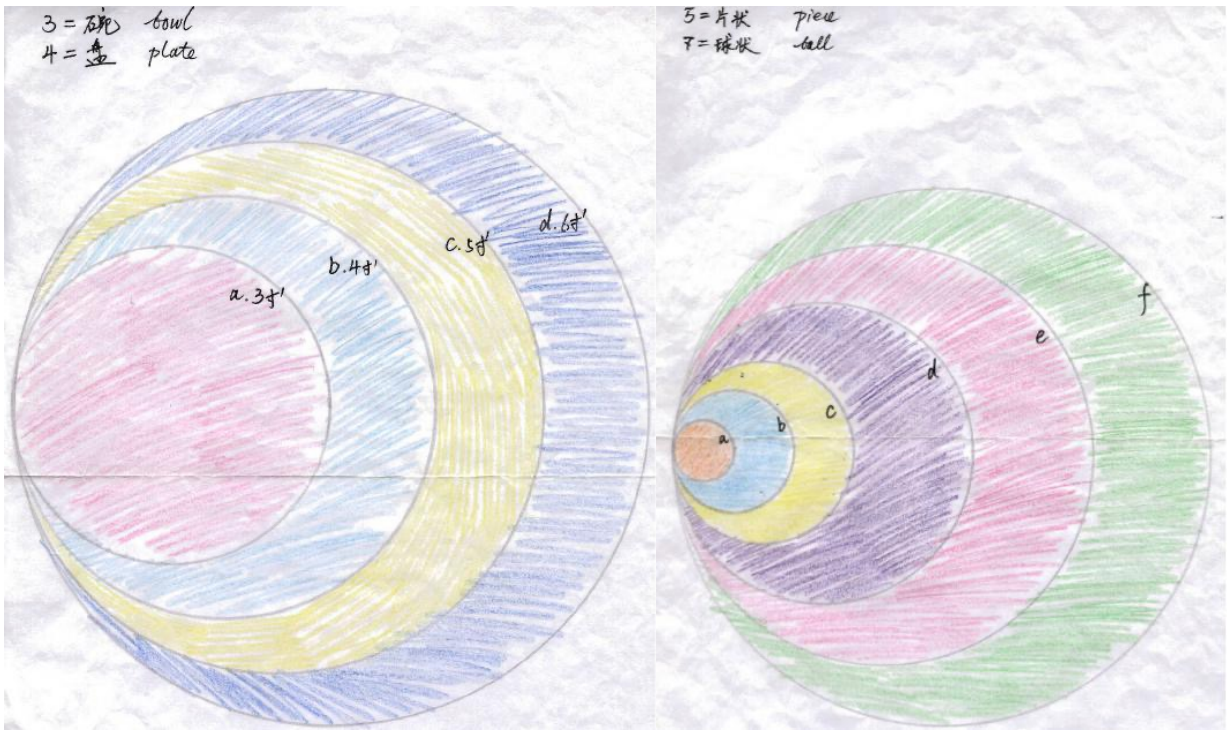
For the cross-sectional study, the minimum sample size was 157. This study included 201 pregnant women and 204 pairs of postpartum mothers and newborns. The sample size has reached the minimum requirement [106, 107].

Picture 1. 2 Tools for 24-h dietary recall

1.7.5 Data collection

After obtaining permission from hospitals and rural clinics, in the early stage of the data collection, the researcher collected all the data personally. Generally, it was not easy to gain the trust of pregnant women and mothers in China due to the disturbance of various salesmen. Therefore, in this study, the medical staff explained this study to pregnant women and postpartum mothers firstly and then introduced the researcher. After informed consent, face to face interview with a semi-structured questionnaire, dietary surveys and anthropometric measurement etc. were conducted. In addition, several medical staffs were carefully trained by the researcher. They helped in performing interviews in the hospital or by phone for collection of follow-up information.

The tools used during data collection included weight scale, height ruler, MUAC (Mid-upper arm circumference) measuring ruler, measuring cup, measuring spoon, pictures showing the size of plates, bowls or portion of food etc. (see Picture 1.2 and Picture 1.3).



Picture 1. 3 Pictures to show the size of plates, bowls or portion of food

1.7.6 Data quality control

There were about 10 pre-tests of each questionnaire, before the large-scale data collection began.

Beside preliminary survey tests, timely adjustments of the structure and questions of the questionnaire were made to facilitate understanding. For example, filling in a lot of background information at the beginning of the interview may cause the mother's doubts. So, the basic information such as address, telephone, family income, etc. was moved to the end of the interview. In this way the response rate could be improved.

The data was entered into the SPSS system in time. If a missing value was found, the researcher immediately communicated with the interviewees over the phone to complete the questionnaire. In addition, for better understanding of the quantitative information, qualitative data was collected through FGDs as a supplementation.

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Chapter 2

Dietary Intake and Food Habits of Pregnant Women Residing in Urban and Rural Areas of Deyang City, Sichuan Province, China

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2 Dietary Intake and Food Habits of Pregnant Women Residing in Urban and Rural Areas of Deyang City, Sichuan Province, China

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Abstract

Micronutrient deficiencies and imbalanced dietary intake tend to occur during the reproductive period among women in China. In accordance with traditional Chinese culture, pregnant women are commonly advised to follow a specific set of dietary precautions. The purpose of this study was to assess dietary intake data and identify risk factors for nutritional inadequacy in pregnant women from urban and rural areas of Deyang region, Sichuan province of China. Cross-sectional sampling was applied in two urban hospitals and five rural clinics (randomly selected) in Deyang region. Between July and October 2010, a total of 203 pregnant women in the third trimester, aged 19–42 years, were recruited on the basis of informed consent during antenatal clinic sessions. Semi-structured interviews on background information and 24-h dietary recalls were conducted. On the basis of self-reported height and pre-pregnancy weight, 68.7% of the women had a pre-pregnancy body mass index (BMI) within the normal range (18.5 ≤ BMI < 25), 26.3% were found to be underweight with a BMI <18.5 (20.8% in urban vs. 35.6% in rural areas), while only 5.1% were overweight with a BMI ≥30. In view of acceptable macronutrient distribution ranges (AMDRs) the women‘s overall dietary energy originated excessively from fat (39%), was low in carbohydrates (49.6%), and reached the lower limits for protein (12.1%). Compared to rural areas, women living in urban areas had significantly higher reference nutrient intake (RNI) fulfillment levels for energy (106.1% vs. 93.4%), fat (146.6% vs. 119.7%), protein (86.9% vs. 71.6%), vitamin A (94.3% vs. 65.2%), Zn (70.9% vs. 61.8%), Fe (56.3% vs. 48%), Ca (55.1% vs. 41%) and riboflavin (74.7% vs. 60%). The likelihood of pregnant women following traditional food recommendations, such as avoiding rabbit meat, beef and lamb, was higher in rural (80%) than in urban (65.1%) areas. In conclusion, culturally sensitive nutrition education sessions are necessary for both urban and rural women. The prevalence of underweight before conception and an insufficient supply of important micronutrients were more pronounced in rural areas. Therefore, attention must be given to the nutritional status, especially of rural women before, or at the latest, during pregnancy.

Keywords: food habits; 24-h dietary recall; pregnancy; urban; rural; China

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2.1 Introduction

Since 2006, China had entered the fourth wave of a baby boom period with an annual increase of about 20 million babies [1]. Research at the international level shows that maternal malnutrition is linked to fetal programming for adult diseases and increases the risk of pregnancy-associated complications [2–6]. In China, maternal anemia (Hb < 110 g/L) (14.5%) [7], nutritional deficiencies of Ca, Fe, Zn, vitamin A, folic acid and protein as well as low energy intake are common [8–12]. Based on the results of a study conducted in Chengdu, the capital of Sichuan province, the prevalence of anemia among pregnant women in the third trimester was 35.0% [13]. However, instead of the internationally accepted anemia cutoff point for pregnant women of Hb < 110 g/L [14], a lower threshold of Hb < 100 g/L was applied by Zhou et al. [13]. In one study, which included 292,568 women in three provinces of China, the prevalence of low body mass index (BMI) before conceiving was 21.6% (BMI < 18.5, urban 24.9% vs. rural 21.0%) [15]. Both pre-pregnancy underweight and maternal anemia are known to be associated with an increased incidence of low-birth-weight (LBW: <2.5 kg) and prematurity [15,16]. In eight provinces of China, the prevalence of premature birth (28–37 weeks), LBW, and high birth weight (>4 kg) of neonates was 9.6%, 3.9%, and 9.2%, respectively, with higher proportions of prematurity (13.1% vs. 8.4%) and LBW (8.1% vs. 2.4%) in urban than in rural areas. On the other hand, slightly more babies with high birth weights were found in rural than in urban regions (10.0% vs. 7.1%) [17].

For more than a decade, China has been facing the ―double burden‖ of under- and over-nutrition [18,19]. The Chinese diet became proportionately rich in fat, as the dietary energy from fat increased from 22% in 1989 to 31% in 2000. In 2000, 44.4% of the Chinese population aged 20–59 had a fat intake exceeding 30% of the total energy intake [18]. Regarding food intake, rural residents in China appeared to consume more grains and fewer animal-based foods than urban residents [20], which is well known to be associated with a lower energy and macro- as well as micro-nutrient intake [21,22]. Furthermore, in accordance with traditional Chinese culture, women are expected to follow a set of dietary precautions during the childbearing period [23–25]. Research indicates that most of these traditional food taboos have no scientific justification or are even harmful to women‘s health [25]. On this basis, the objectives of this study were to provide

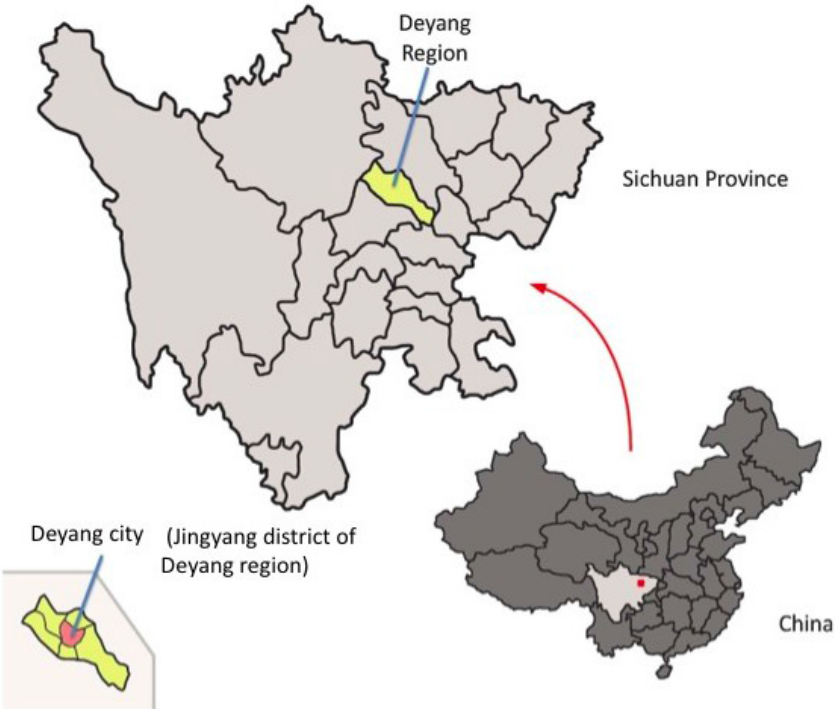
baseline data on dietary intake and food habits in order to identify the risk of nutritional inadequacy, and to give appropriate dietary recommendations for pregnant women in urban and rural areas of Deyang City, Sichuan province, China.

2.2 Participants and Methods

2.2.1 Study Design and Population

Since, on a national level, the vast majority (96%) of Chinese women delivered in medical institutions during 2006–2010 [26], a cross-sectional study design was applied in medical institutions. Two of five hospitals in the urban part of Deyang City (Jingyang District, see Figure 2.1) and five of 12 clinics in rural areas were randomly selected. Between July and October 2010, a total of 203 pregnant women in the third trimester, aged 19–42, were recruited with informed consent during antenatal clinic sessions. Finally, 201 pregnant women were analyzed (62.7% in urban, 37.3% in rural areas); two were excluded because their residences were missing. A semi-structured interview on background information and a 24-h dietary recall were conducted directly in the clinic and/or during a home visit, depending on the time availability of the pregnant women.

Figure 2. 1 Map of study area



2.2.2 Dietary Assessment

To characterize the average usual dietary intake of pregnant women in the study area, the 24-h dietary recall method was applied. Women were prompted to recall all food items including snacks, extraordinary beverages and shared dishes consumed the preceding day and were advised to describe their food intake according to daily routine. To help the respondents estimate portion sizes, measuring aids were shown to the women: two self-painted templates illustrating standardized sizes of Chinese dishware and rough suggestions of portion sizes of food consumed; household measures were also used, including a set of spoons and a measuring cup to quantify smaller portion sizes and beverage volume, respectively. At the end of the recall, items noted down were read to the respondent in order to guarantee completion of the protocol. Traditional food beliefs and taboos were defined on the basis of the knowledge of medical staff and published evidence [25,27]. Specific questions on nutrient supplementation were not asked.

2.2.3 Anthropometric Assessment

For a rough estimate of nutritional status, anthropometric data including height, pre-pregnancy weight, mid-upper arm circumference (MUAC), and weight in late pregnancy were assessed. Except for MUAC, the women themselves provided all the data. Currently, there is no international consensus on the MUAC cutoffs for the detection of women with poor nutritional status, who are simultaneously at risk for adverse birth outcomes. On the basis of several studies [28–33] and due to the need for international comparison, we chose a MUAC value of 23 cm as the cutoff point. Since the WHO collaborative study [34] was clearly relevant to the Chinese population, proposing a MUAC <22 cm as a proxy measure for poor maternal nutritional status, this cutoff point is also referred to in this study. This allows a more pictorial representation of the sample and improves comparison, as this cutoff is cited by a range of studies [3,35,36]. In reference to WHO BMI standards [37], the health status of women before pregnancy was defined as underweight (BMI < 18.5), normal (18.5 ≤ BMI < 25), overweight (BMI ≥ 25), or obese (BMI ≥ 30).

2.2.4 Statistical Methods and Food Intake Analyses

Statistical data analyses were performed using the SPSS 19.0 software package (IBM, New York, NY, USA). Significant differences between urban and rural areas were determined at $p \leq 0.05$. The 24-h recall records were converted to nutrient intakes using the software NutriSurvey. Preparatory work included the adjustment of food databases for Chinese conditions, the definition of standard food recipes based on a comparison of several Sichuan cuisine books, and the conversion of recalled volumes into weights.

Adequacy of nutrient consumption was evaluated by applying the Chinese dietary reference intakes (DRIs) with light physical activity level (PAL) [38] adopted by the Institute of Nutrition and Food Safety China (INFSC) [39,40]. Reference values were recommended nutrient intake (RNI) or adequate intake (AI) for pregnant women. To better judge the need for nutritional assistance, insufficient nutrient intake was determined as below 80% of the RNIs or AIs respectively, while excessive intake of energy or fat was set above 120% of reference. The rationale for using this 20% allowance was that the DRIs are designed with a risk allowance, which better satisfies individual physiological fluctuations of nutrient needs. Thus, the failure to attain the reference intakes may not be equated with falling below the nutrient requirements, as a reference value is not a strict threshold [41].

2.2.5 Ethical Clearance

The study conformed to the provisions of the 1995 Declaration of Helsinki (revised in Edinburgh 2000) and was approved by the Medical Committee of Deyang City, China. The purpose of the study was explained to pregnant/lactating women and parents of eligible children, who gave informed consent.

2.3 Results

2.3.1 Socio-Demographic Characteristics

Most respondents were Han Chinese (97%), primiparae (85.4%), had completed at least primary education (95.5%), and contributed to their families' income (74.6%). Before conceiving, most

were employed in the service sector (36.7%), about one fifth were homemakers (19.1%), and a similar number were employed in skilled or professional labor (19.7%). Others reported having been self-employed (14.9%) or engaged in unskilled or manual work (9.6%). Compared to rural areas, a higher proportion of women from urban areas had a college degree (39.2% vs. 8.2%), were self-employed (19.8% vs. 6%) or engaged in skilled or professional labor requiring post-secondary degrees (24.7% vs. 10.5%), and contributed a higher percentage to the total household income. A higher proportion of women from the rural sites experienced unemployment (22.4% vs. 17.4%) and exceeded the employment rates of their urban counterparts in the service sector (44.8% vs. 32.2%) and the unskilled labor force (16.4% vs. 5.8%) before pregnancy.

Including the expected child, rural women appeared on average to have significantly ($p = 0.009$) more children (1.28 ± 0.53) at a significantly ($p < 0.001$) earlier age (24.1 ± 4.65 years) than urbanites, at an average of 26.5 ± 3.89 years and with 1.09 ± 0.29 children. In line with the one-child family policy, the clear majority of urban women were primiparae (90.8%) compared to rural subjects (75.5%). Third pregnancies occurred only in rural areas (3.8%).

On the basis of self-reported height and pre-pregnancy weight, most women had a pre-pregnancy BMI within the normal range before conceiving (68.7%; $18.5 \leq BMI < 25$). About a quarter were found to be underweight with a BMI of <18.5 (26.3%; 20.8% in urban vs. 35.6% in rural areas); while a small number were overweight with a BMI of ≥25 to <30 (5.1%). None of the women had been obese ($BMI \geq 30$) before conceiving. During the third trimester, the mean value of MUAC was 25.8 ± 2.9 cm, showing no significant ($p = 0.130$) difference between women from urban (26.1 ± 2.7 cm) and rural (25.4 ± 3.3 cm) areas. When applying 22 cm as the cutoff point for MUAC, 7.3% of pregnant women were found to be malnourished (6.7% vs. 8.3% in urban and rural areas, respectively). Considering a MUAC of 23 cm as threshold, the number of women with poor nutritional status increased to 14.7%, (11.8% vs. 19.4% in urban and rural areas, respectively).

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Table 2. 1 Stated reasons for practicing special dietary precautions during pregnancy among women who adhered to any food taboos (n = 142)

Food taboos during the pregnancy & qualitative analysis of cultural fears entailed			
	Urban n = 82	**Rural n = 60**	
Metaphysically "cold" foods	n (%)	n (%)	
Crab	0	1 (1.7)	May induce premature birth or miscarriage
Soft-shelled turtle	0	1 (1.7)	
Snake	1 (1.2)	0	
Ice cream	0	1 (1.7)	
Sprite	0	1 (1.7)	
"cool" foods	4 (4.9)	8 (13.3)	
Metaphysically "hot" foods	n (%)	n (%)	
Dog	1 (1.2)	2 (3.3)	Dog flesh is hot in the hot-cold classification of foods. The baby may bite the mother
Metaphysically "toxic" foods	n (%)	n (%)	
Rabbit	58 (70.7)	40 (66.7)	Causes harelip or cleft palates in the fetus, rabbit head
Eel	8 (9.8)	10 (16.7)	Causes foaming at the mouth of the newborn
Beef	20 (24.4)	22 (36.7)	Child may have a stubborn temper like an ox
Fish	1 (1.2)	2 (3.3)	Baby may get bacterial infection of the skin more easily
Duck	7 (8.5)	9 (15)	Newborn's neck will be weak or lack power. Causes duck head
Lamb, mutton, goat	62 (75.6)	49 (81.7)	Fetus will suffer from epilepsy
Sow	1 (1.2)	1 (1.7)	
Chinese anise	1 (1.2)	0	Harmful due to lots of flavors, may contain rosin (colophony), not fresh enough, traditional reasons
Clove	1 (1.2)	0	
Hot pot	1 (1.2)	0	
Braised/stewed meat	4 (4.9)	0	
Bacon	1 (1.2)	0	
Leek	1 (1.2)	0	
Sauerkraut	1 (1.2)	0	

Modified from Lee et al. 2009 [25].

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2.3.2 Antenatal Food Habits and the Cultural Beliefs and Fears Entailed

The most important sources from which participants heard about traditional food culture were the family (63.5%), elders (37.2%), and non-family including friends and neighbors (35.8%). Books and booklets played a minor role in transmitting knowledge about traditional rituals or taboos (6.6%).

Seventy point six percent (70.6%) of participants adhered to specific food taboos during their pregnancies while 29.4% did not restrict their eating. The different reasons for these food precautions were qualitatively collected (see Table 2.1).

Eighty percent (80%) of rural women practiced some food avoidance, which was a markedly higher percentage compared to 65.1% in the urban setting. Among the women adhering to food taboos during pregnancy, the most commonly cited food items were lamb, mutton, goat (78.2%) followed by rabbit (69%), beef (29.6%), eel (12.7%), duck (11.3%), foods with a ―too cold‖ property (8.5%), or fish (2.1%). Spicy foods (e.g., hot pot) and foods with multiple flavors (e.g., clove, braised/stewed meat) were avoided by 7% for food purity and perceived safety reasons.

Half (54.7%) of the women interviewed increased their consumption of some types of foods during pregnancy. A higher percentage of urban subjects (60.3%) than rural subjects (45.3%) said they had increased consumption of any foods. Soup with varieties of meat and vegetables accounted for 85.5% of all food increases. Three subjects indicated that they were eager to consume ―as much soup as possible‖ for the wellbeing of both mother and child. On the whole, soup with Chinese olives and pig stomach (n = 30), salsola grass and meat (n = 18), and green beans and pig intestine (n = 15), were the most commonly mentioned types of soup, with these ingredients appearing in a large number of other soups cited as well.

The concept of "reducing internal heat of the fetus" was by far the most frequently stated reason for almost all types of food increases. (In traditional Chinese medicine, the state of health is seen as a balance between yin and yang, or cold and hot. Illness is viewed as an imbalance between these two opposed forces. Classification according to yin and yang applies to many things such

as stages of life, foods, and herbs. To assure one's vital energy (ch'i) [42] the "right" foods have to be selected according to the particular life stage or health condition of the individual [43]. Cold and hot are defined by type of food, thereby the terms yin and yang suggest "the inherent nature of the food", not its temperature [44]. Pregnancy is believed to cause a harmful disequilibrium of yin and yang in the female body [45]. During the first three months of pregnancy, a woman is believed to be feeble, cold, and lacking in vigor. In the subsequent three months she is in a neutral condition and in the final three months she is hot and tonic. Hence, during second trimester a woman starts eating cold foods to better counteract the hot condition that may arise in the final stage of pregnancy [46].) Other reasons included "nutritious" (fish soup, n = 4), "improves breast milk flow" (soup with crucian carp, n = 3), "improves birth weight" (soup with cuttlefish, n = 2), "good for baby's stomach" (soup with Chinese redbud flower and pig stomach, n = 1), "prevents nausea" (water with towel gourd, n = 1), and "promotes baby's intelligence" (walnut, n = 1). The most mentioned non-soup food items were boiled or fried goose eggs (n = 9), assumed "to avoid boils in the newborn". The consumption of duck eggs (n = 3) was believed to "reduce fever".

Table 2. 2 Energy derived from protein, fat and carbohydrates expressed as the percentage of the total energy intake (kcal) of pregnant women living in urban and rural areas

% of energy	AMDRs •	Total (n = 192)	Urban (n = 125)	Rural (n = 67)	p-Value *
Derived from protein	10–15	12.1 ± 2.9	12.3 ± 2.8	11.6 ± 3	0.118 ns
Derived from fat	20–30	39 ± 11.2	40.4 ± 10.8	36.6 ± 11.6	0.025 *
Derived from carbohydrate	55–65	49.6 ± 11.4	48.1 ± 11.1	52.4 ± 11.7	0.012 *

• Acceptable macronutrient distribution ranges (AMDRs) adopted by the INFSC [39,40]; * Significance level; $p > 0.05$ non-significant (ns); $p \leq 0.05$ significant (*).

2.3.3 Result of 24-h Recall

2.3.3.1 Dietary Intake of Participants at the Two Survey Sites (Urban vs. Rural)

On average, 12.1%, 39.0%, and 49.6% of dietary energy originated from protein, fat, and carbohydrates, respectively. The contribution of fat to total energy was higher among urban

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Table 2. 3 Energy and nutrient intakes of rural and urban pregnant women in Deyang city in relation to fulfillment of the national recommended nutrient intakes (RNIs) (adopted by the INFSC 2002/2004)

Energy and nutrient (unit/day)	RNIs/ AIs •	Total (*n* = 192)			Urban (*n* = 125)			Rural (*n* = 67)			*p*-Value *
		Mean ± SD	% fulfillment RNI	Range	Mean ± SD	% fulfillment RNI	Range	Mean ± SD	% fulfillment RNI	Range	Mean ± SD
Energy (kcal)	2300	2338 ± 844	101.7	566–5705	2441 ± 834	106.1	767–5705	2148 ± 837	93.4	565–4514	0.021 *
Protein (g)	85	69.4 ± 26.7	81.6	15.3–171.2	73.9 ± 26.9	86.9	16.7–171.2	60.9 ± 24.4	71.6	15.3–130.6	0.001 ***
Fat (g)	51–77 †	105.7 ± 58	137.3 ‡	11.3–348.1	112.9 ± 57.8	146.6 ‡	11.3–348.1	92.2 ± 56.4	119.7 ‡	14.8–282.1	0.018 *
Carbohydrate (g)	316–374 †	281.5 ± 103.9	89.1 §	89.1–670.6	286.5 ± 102.5	90.7 §	124.2–616.6	272.1 ± 106.6	86.1 §	89.1–670.6	0.311 ns
Vitamin A (μg RE)	900	757.5 (±*920.8*)	84.2	10–8520.7	849.1 (±*1032*)	94.3	46.1–8520.7	586.4 (±*638.1*)	65.2	10–3093	0.005 **
Vitamin C (mg)	130	104.3 (±*110.1*)	80.2	1.6–744.1	106.8 (±*112.4*)	82.2	1.6–744.1	99.7 (±*106.4*)	76.7	7.28–697.8	0.589 ns
Thiamin (B1) (mg)	1.5	0.81 ± 0.41	54	0.25–2.66	0.81 ± 0.39	54	0.25–2.53	0.79 ± 0.44	52.7	0.26–2.66	0.517 ns
Riboflavin (B2) (mg)	1.7	1.19 ± 0.58	70	0.16–4.26	1.27 ± 0.58	74.7	0.16–4.26	1.02 ± 0.53	60	0.17–2.84	0.003 **
Ca (mg)	1200	602.1 ± 378.3	50.2	33.5–2788.4	660.8 ± 379.6	55.1	81.3–2788.4	492.5 ± 353	41	33.5–1530.9	<0.001 ***
Mg (mg)	400	300.4 ± 164.5	75.1	77.9–1202.8	311.5 ± 160.9	77.9	97.5–1127.6	279.8 ± 170.4	70	77.9–1202.8	0.069 ns
Fe (mg)	35	18.7 ± 9.8	53.4	5.2–88.9	19.7 ± 10.4	56.3	5.2–88.9	16.8 ± 8.3	48	6.2–58.2	0.019 *
Zn (mg)	16.5	11.2 ± 4.7	67.9	3.5–32.6	11.7 ± 4.8	70.9	4.3–32.6	10.2 ± 4.5	61.8	3.5–28	0.025 *

• Recommended nutrient intakes (RNIs) and adequate intakes (AIs)—adopted by the INFSC [39,40]; † As RNI values are confined to protein and micronutrients, we judged the average intake of fat and carbohydrates by referring to self-calculated healthy ranges in g/day on the basis of the AMDRs, defined as: "a range of intake for a particular energy source (protein, fat, or carbohydrate), expressed as a percentage of total energy (kcal), that is associated with reduced risk of chronic disease while providing adequate intakes of essential nutrients" [47]; Calculated from total energy in kcal, using the energy yield of macronutrients: carbohydrate = 4 kcal/g; protein = 4 kcal/g; fat = 9 kcal/g [48,49], assuming the AMDRs: fat (20%–30% of energy), carbohydrates (55%–65% of energy) [39,40]; ‡ percentage relates to the upper limit of the self-calculated reference range; § percentage relates to the lower limit of the self-calculated reference range; Significance level: $p > 0.05$ non-significant (ns);

$p \leq 0.05$ significant (*); $p \leq 0.01$ very significant (**); $p \leq 0.001$ highly significant (***).

mothers, though the opposite was the case with respect to the proportion of energy from carbohydrates. The percentage of energy derived from protein did not differ significantly between the two survey sites (see Table 2.2).

Intakes of energy and selected nutrients are summarized in Table 2.3. Analyses of urban-rural differences revealed not only significant differences in the intake of energy but also in protein, fat, vitamin A, riboflavin, Ca, Fe, and Zn. In general, urban women invariably exceeded mean values of the rural women. Yet, at both sites, average intake of thiamin, riboflavin, Ca, Mg, Fe, and Zn was below 80% of RNI. Energy consumption fell into a desirable range close to RNI fulfillment, protein intake in urban areas was slightly above whilst the rural share fell short of 80% of RNI.

With respect to judging the risk of chronic disease, the intake of fat clearly exceeded the upper limit of the self-calculated reference range, whilst the intake of carbohydrates fell below the lower limit of the healthy range.

2.3.3.2 Food Groups and Sources of Energy and Nutrients

Rice was the most popular staple food in the total study population with a daily consumption of 178.4 g/day, which was markedly higher than the consumption of other grains (57.5 g/day) (see Table 2.4).

Significant differences in food group consumption were restricted to the categories of cow's milk and seafood. Further, average consumption of vegetables and visible oils and fat was invariably found to be significantly higher for the urban site. There was a slight trend suggesting the share of animal-based foods to be higher among urban women. This assumption is substantiated when comparing average animal-based food consumption, including animal fats, meats, poultry, offal, seafood and secondary products such as chicken eggs, milk, or dairy products at the urban (403.6 ± 252.9 g/day) and rural sites (305.8 ± 220.8 g/day) in the Deyang area ($p = 0.008$ **). The daily intake of plant-based food was comparable ($p = 0.326$ ns) in rural (1049.1 ± 716.5 g/day) and urban areas (1107.9 ± 714.7 g/day).

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Table 2. 4 Average food consumption of pregnant women living in urban and rural areas according to selected food groups

Amount (g/day)	In total (n = 192)	Urban (n = 125)	Rural (n = 67)	p-Value *
Rice/its products	178.4 ± 94.5	176.6 ± 105.1	181.9 ± 71.2	0.101 ns
Wheat and other grains/their products	57.5 ± 133.5	57.6 ± 93.2	57.4 ± 187.8	0.053 ns
Starchy tubers, roots	30.6 ± 63.2	32.4 ± 66.8	27.3 ± 56.1	0.911 ns
Soy products	56.1 ± 138.4	65.3 ± 151.6	38.9 ± 108.6	0.459 ns
Soya sauce and bean paste	6.9 ± 6.2	7.4 ± 6.4	6.0 ± 5.7	0.123 ns
Vegetables	164.7 ± 170.4	183.7 ± 186.9	129.3 ± 128.4	0.042 *
Preserved vegetables	11.7 ± 52.4	15.6 ± 64.1	4.4 ± 12.2	0.083 ns
Fruits	517.1 ± 626.3	498.6 ± 619.2	551.6 ± 642.6	0.332 ns
Nuts and seeds	26.8 ± 52.0	29.0 ± 51.8	22.6 ± 52.6	0.202 ns
Pork	100.8 ± 105.1	100.7 ± 96.5	101.0 ± 120.4	0.567 ns
Other meats/poultry/offal	37.0 ± 58.8	41.0 ± 62.7	29.5 ± 50.4	0.120 ns
Cow's milk	147.3 ± 196.3	172.9 ± 203.9	99.5 ± 172.7	0.012 *
Chicken eggs	55.0 ± 58.1	51.5 ± 53.6	61.7 ± 65.5	0.624 ns
Seafood	16.8 ± 42.9	22.4 ± 50.2	6.4 ± 20.8	0.006 **
Vegetable oil	44.4 ± 37.0	49.2 ± 39.2	35.5 ± 30.7	0.016 *
Animal fats	1.2 ± 4.8	1.6 ± 5.8	0.3 ± 1.9	0.026 *

* Significance level; $p > 0.05$ non-significant (ns); $p \leq 0.05$ significant (*); $p \leq 0.01$ very significant (**); $p \leq 0.001$ highly significant (***).

The contribution of different food sources to the overall dietary intake was another focus of the study. Fats, oils, and lard contributed 17.5% to total energy and made up nearly half (42.8%) of the total dietary fat. Animal-based foods (50.2%, 35.2 g) and foods from plant sources (44.8%, 31.4 g) made a balanced contribution to total protein. By contrast, the basic source of vitamin A was plant-based (62.7%) as compared to 34.2% derived from animal-based foods, equaling 475.5 μg and 259.5 μg of total intake, respectively. A similar pattern applied to the overall Fe and Zn intake with 71.4% (13.5mg) and 53.8% (6.4 mg) respectively originating from plant foods as compared to merely 20.4% (3.9 mg) and 30.8% (3.7 mg) originating from animal foods. With respect to the total Ca, 35.4% (224.4 mg) was provided by plant-based foods and 45.3% (287.4 mg) was derived from animal-based foods. Milk and dairy products contributed the most to the overall Ca intake, with 36.2% (229.7 mg).

Furthermore, in this study, dietary diversity was generally found to be higher among urban women. This conclusion is drawn from the finding that snacking times, the total number of snacks, as well as the number of different dishes with various ingredients consumed at one sitting tended

to be higher among urban women. Among rural women, repeatedly serving the same dish or leftovers was more common. In total, for the urban area about 263 different types of food items have been recorded during evaluation of the 24-h recall, as compared to 200 different types of foods for rural women which equals a difference in variety of 24%.

2.4 Discussion

2.4.1 Food Taboos and Special Foods Consumed during Pregnancy in Rural and Urban Areas

With respect to taboos among Hong Kong Chinese women, avoidance of snake (92%), iced foods (83%), or beef (40%) is still common during pregnancy. Lee et al. [25] point to the danger of nutritional deficiencies being caused or aggravated by overzealous adherence to dietary prescriptions. In our results, it appears that traditional dietary practices did not negatively affect maternal nutritional status. This was based on two findings. First, there were no significant differences in nutrient intake among those practicing any food taboos or increasing consumption of special foods, and those who did not change their eating behavior during pregnancy. Second, the great dietary diversity in Chinese cuisine provides adequate alternatives to meet a balanced diet. However, beef or fish (including eel), which were avoided by some women, are widely considered to be healthy and nutritious food choices, hence it may be desirable to encourage women to include these items in their diet. Furthermore, the socio-moral pressures that pregnant women face from non- or partial adherence to food taboos should not be overlooked. In the study of Lee et al. [25], family (65%) and friends (22%) were listed as the most important channels for imparting antenatal taboos, which is consistent with outcomes of this study. The predominant role of the family in promoting cultural practices implies that various expectations are imposed upon pregnant women, making the psycho-cultural experience of pregnancy even more complicated. As a consequence, in the event of miscarriage or fetal ill-health, women might be held accountable by their relatives [25]. This suggests the need to clarify that the principles behind taboos are based on folklore rather than on scientific evidence.

With respect to differences between rural and urban areas, more rural than urban women practiced food avoidance, while more urban than rural women increased their consumption of foods. An

explanation for this could be that rural women were more influenced by traditional culture, while urban women had a higher educational level and more access to nutritional knowledge.

2.4.2 Dietary and Food Intake Patterns

Evaluation of the 24-h recalls indicated the need to improve the dietary intake of pregnant women living in Sichuan province, although the overall picture showed some satisfactory dietary habits as well.

2.4.2.1 Dietary Intake in Rural and Urban Areas

Findings of this study clearly show that there are distinct differences in energy as well as nutrient intakes among pregnant women residing in urban and rural areas of Deyang city (Table 2.3). In general, average energy consumption met the range of 20% allowance of RNI. Referring to the macronutrient composition of pregnant women's diets, the consumption of carbohydrates could be increased to meet the lower limit of the self-calculated healthy range. Protein intake was deficient in the rural areas, whilst urbanites were still above 80% of RNI. The assumed fat intake was excessive at both survey sites, exceeding the upper healthy range. The dietary intake of most micronutrients was more or less deficient in both study sites but low intake was more pronounced in rural than in urban areas. The observed trend of higher intakes among urban mothers is not holistically reflected by the 2002 NNHS of pregnant women [50] but is, however, widely mirrored by data of the 1992 and 2002 NNHS including individuals of all ages [20] and is clearly evident in the data on adult women in Jilin province [21]. In summary, apart from fat intake, urban women had more nutritious and diversified diets than rural women in this study.

Taking these factors together, it can be reasonably assumed that rural women are more vulnerable to nutritional imbalances than are urban women.

2.4.2.2 Food Group Consumption in Rural and Urban Area

As indicated in Table 2.4, urban women consumed more animal-based foods compared to rural women. Inferentially, rural women could increase animal foods to improve their dietary quality.

Normally, both rural and urban women bought food from local traditional markets. Food diversity is much higher in urban than in rural markets and the markets are much closer to home for urban families than for rural ones. High price and low availability in rural markets could be the reason that rural women consumed less cow's milk and seafood than urban women (Table 2.4). Low food diversity in rural markets could also be responsible for lower vegetable consumption by rural women. Furthermore, rural women tended to eat home-grown vegetables of which there were limited varieties, which is assumed to contribute to the insufficient representation of vegetables in rural women's diets.

Table 2. 5 Average amount of selected food groups consumed by pregnant women (n = 310) in the 2002 NNHS [50] compared with consumption patterns of participants in our study (n = 192) and recommendations by Yang, 2008 [51]

Food group (g/day)	2002 NNHS National level China Pregnant women (*n* = 310) (whole pregnancy period)	Deyang, 2010 Urban and rural areas Pregnant women (*n* = 192) (3rd trimester)				Recommendation (Yang, 2008)
		In Total (*n* = 192)	Urban (*n* = 125)	Rural (*n* = 67)	*p*-Value*	
Staples	461	266.6 ± 179.4	266.6 ± 159.4	266.6 ± 213.1	0.882 ns	250–400
Soy products	13	63.0 ± 138.6	72.7 ± 151.8	44.9 ± 108.5	0.114 ns	30–50
Vegetables	285	176.4 ± 174.1	199.3 ± 190.8	133.8 ± 128.1	0.010 **	300–340
Fruits	81	517.1 ± 626.3	498.6 ± 619.2	551.6 ± 642.6	0.332 ns	200–400
Meats, fish	96	154.6 ± 123.9	164.0 ± 124.3	137.0 ± 122.2	0.061 ns	125–225
Milk, dairy products	19	158.7 ± 198.7	186.5 ± 207.0	106.9 ± 172.0	0.006 **	300
Chicken eggs	25	55.0 ± 58.1	51.5 ± 53.6	61.7 ± 65.5	0.624 ns	- [1]
Vegetable oil	31	44.4 ± 37.0	49.2 ± 39.2	35.5 ± 30.7	0.016 *	25

Significance level: $p > 0.05$ non-significant (ns); $p \leq 0.05$ significant (*); $p \leq 0.01$ very significant (**); $p \leq 0.001$ highly significant (***).

[1] no recommendation

3.4.2.1 Comparison of Dietary Patterns with Related Studies

With respect to the daily reference ranges suggested by Yang [51], women in the Deyang study sample had a better supply of animal-based foods than the pregnant women in the 2002 NNHS

study [50] (see Table 2.5). Furthermore, fruits seemingly enjoyed great popularity as an integral part of the daily diet, although the very high fruit consumption in the Deyang study sample (Table 2.5 and Table 2.6) must be seen in relation to the widespread consumption of watermelon during the study period that may have boosted the average weight. Intakes of staples and meat products meet the recommended range, but scatter at the lower limit, thus indicating a possible area where nutrient intake could be improved. The category of milk and dairy products (159 g/day), though being much more satisfactory compared to 19 g/day in the 2002 NNHS, could be boosted still further (Table 2.5). Of special concern is the excessive addition of cooking oil during food preparation, which results in passive overconsumption of fat. In theory, high fat content not only increases the energy content but, first and foremost, negatively affects protein and micronutrient density [52,53]. In summary, when compared with participants of the 2002 NNHS [54], participants in the Deyang study sample appeared to consume considerably more livestock products and cooking oils, and far fewer staples and vegetables. Except for oil intake, the contribution of all other food categories to the total diet should be increased, especially in women with a low BMI.

Table 2. 6 Average food consumption by the Chinese population in 1982, 1992, and 2002 [20], compared with food groups consumed by pregnant women in the Deyang study.

Food group gram per day	**NNHS National level China Covering individuals of all ages**			**Deyang, 2010 Urban and rural areas Pregnant women (3rd trimester)**
	1982	1992	2002	2010
Grains/its products (g/day)	510	440	402	236
Vegetable & fruit (g/day)	368	369	331	724
Animal sources (g/day)	61	117	160	368
Visible oil and fat (g/day)	18	30	41	46

For the period 1982 to 2002, Table 2.6 clearly demonstrates the general trend toward an energy-dense diet that is low in carbohydrates. Altogether, the share of staples such as rice, cereals, or potatoes is declining while the share of animal-based foods and vegetable oils is rising. Although the data of this study smoothly integrate into the overall image of a continuing re-structuring of

dietary patterns, it is important to keep the limitations in mind when comparing a representative national sample with a much smaller local sample.

2.4.3 Recommendations to Improve Dietary Quality

2.4.3.1 Improving Nutrient Density of the Diet in Rural and Urban Areas

High fat intake was common in both urban and rural areas equaling 146.6% and 119.7% of the upper desirable limit (Table 2.3). The percentage of energy derived from fat shown in the Deyang study (39%) is quite alarming, though it is not reflected in the BMI distribution of Deyang respondents. From the mid-1960s onwards, a steady increase in dietary energy worldwide took place [19,55]. Fried dishes (fried-fragrant, stir-fried, or deep-fried) are very popular in Sichuan province and are, thus, firmly established in the daily diet. As expected, in this study vegetable oils alone provided 41.7% of total fat consumed and constitute about half (17.1%) of the recommended maximum percentage of total energy that should be derived from dietary fat (30%) [39,40]. Types of oils consumed were rapeseed oil (93.3%), sesame seed, chili, or salad oil (6.7%). A desirable diet comprises saturated (SFA), monounsaturated (MUFA), and polyunsaturated (linoleic acid—LA; α-linolenic acid—ALA) fats in the ratio of 35%, 44%, and 23%, respectively [56]. Hence rapeseed oil has a good fatty acid composition to complement a well-balanced diet (SFA 8%, MUFA 64%, LA 23%, ALA10%) [57]. Nevertheless, with the unsatisfactory nutrient density we found, it is critically important to encourage women to limit the usage of oil in cooking or, as a second approach, to give priority to non-fried (e.g., red-braised) over fried dishes. Then, nutrient density would be much more satisfactory given that Chinese cuisine also includes a considerable variety of nutrient-dense (meat, grains) and energy-dilute foods (vegetables, legumes, fruits), despite a relatively high percentage of energy as fat from added oils. Thus, small behavioral changes could result in major nutritional improvements. In addition, to further boost nutritional status, it is strongly recommended that the consumption of nutrient-dense foods be increased, while simultaneously curbing oil consumption. This issue is of particular concern, given that the energy consumption shown in our study is not excessive. Both sites are at risk of falling substantially short of the energy reference value unless the reduction in dietary fat is

accompanied by behavioral changes. Furthermore, the nutrient gap with respect to RNIs will remain decisive. Hence, the selection of nutrient-dense foods, accompanied by a restricted usage of cooking oil, is the first order of business if RNIs are to be met.

The intake of visible fats (cooking oils) was not the only matter of concern. Hidden fats from meat products are another challenge. Pork alone provided about 25.8 g fat constituting 24.2% of total fat and 9.9% of total energy consumed. There is no doubt that meat is a great source of protein, but what accompanies the protein must also be considered. Pork provides about 13 g protein per 100 g, but also 37 g fat. Beef, chicken, or fish, on the other hand, provide about 20 g, 12 g, or 17 g of protein but only 4 g, 9 g, or 5 g fat per 100 g, respectively [39,40]. Pork, however, enjoys the highest popularity among the Chinese (Table 2.4), which points to another key issue to be tackled. To conclude, it would be desirable to complement the predominantly pork-based diet by an increased consumption of fish or more lean meats such as beef and chicken. Apart from the nutrient-density of foods, the biological quality of nutrients and their bioavailability must also be considered [52].

3.4.3.2 Improving the Intake of Micronutrients in Rural and Urban Area

Pregnant Chinese women have been reported to be deficient in Fe, Zn, and Ca [12,54]. The 2002 NNHS affirmed inadequate dietary intake of Zn and Ca [50]. Data provided by the Deyang study shows substantial deficiencies in all minerals, with most average intakes falling short of the national RNI with a 20% allowance as a criterion (Table 2.3). According to the 2002 NNHS, the Chinese still consume a largely plant-based diet providing at least 50% of dietary energy and nutrients. Similarly, in the Deyang study, energy and nutrients were largely of plant origin. The high level of phytates in these foods decreases the bioavailability of critical nutrients by forming insoluble and indigestible complexes. The magnitude of this problem becomes especially clear when taking into account the fact that Fe deficiency was still found to be prevalent, despite the high total Fe intake reported among the Chinese population [58]. Hence, both insufficient intake as well as poor bioavailability might account for mineral deficiencies in China.

In our study, 26.2% of all women self-reported having suffered from slight or more severe forms

of anemia before conceiving, equal to 19.3% and 38.8% in urban and rural areas, respectively. During pregnancy this percentage rose to 35.6% for the total sample, and accounted for 32.5% in the urban and 41.2% in the rural areas. Similarly, widespread prevalence of Ca deficiency has been self-reported before (13.1%) and during pregnancy (26.6%, 30.7% in urban vs. 19.0% in rural areas).

Bearing in mind that milk and dairy products provide the richest and most easily absorbed dietary sources of Ca, it might be advisable to further increase overall milk consumption. However, considering the greatly increased production of dairy products from slightly more than 10 million metric tons in 2001 to almost 39 million metric tons in 2009, consistent with an annual growth rate of 26% [59], such a casual recommendation has to be scrutinized as the growing demand for livestock products is likely to have an undesirable impact on the environment [19]. Hence, a moderate consumption (250 mL/day) of milk or dairy products (sample average 159 mL/day) is recommended, with special emphasis on the rural area. Shrimp is also another good source of Ca [53]. Furthermore, nuts (almonds), sunflower or sesame seeds, laver (seaweed) as well as green leafy vegetables are rich in Ca, though inferior due to a high fat content and/or low bioavailability [39,40]. Nevertheless, an increase in their consumption would help to fill the nutrient gap.

Tofu dishes or secondary tofu products were consumed by a relatively small proportion of urban (9.6%) and rural (7.5%) subjects. The following provides a basis for placing greater emphasis on the consumption of tofu in the diet. As ―tofu may be the most popular food made of soy and is an inexpensive, nutritious, and versatile food‖ [60], it is natural to pursue the approach of improving Ca intake first and foremost by boosting the popularity of tofu. Therefore, its supposed equivalence to dairy products as a source of Ca and its superiority in terms of ethical principles (by not exploiting animals for their secondary products) should be the focus. Soybean curd is greatly enriched in Ca as the traditional processing method includes the addition of different coagulants usually powdered gypsum (Ca sulfate) [60]. Distressingly, study results by Ma indicate that phytates in soy products inhibit the absorption of Ca, Fe, and Zn [58]. By contrast, investigations by Weaver et al. [61] maintain that the efficiency of Ca absorption from tofu is equivalent to that of cow's milk. Furthermore, among the few Ca-fortified foods, tofu provides

Ca in concentrations comparable to milk in an acceptably sized portion. In addition, both cow's milk and tofu provide good quality protein [61], with soy-protein being the only plant protein approaching the quality of animal protein [53]. Since 1997, the Chinese government has urged an increase in milk production and consumption as an effective approach to improve the Ca intake of the Chinese population [62,63]. Integrating all this core information, the emphasis on improving Ca intake must not be restricted to dairy products, but rather should be extended to include selected Ca-fortified soybean products such as tofu.

In this study, the overall Fe and Zn intake met only 53.4% and 67.9% of the RNI. Taken together with the above-mentioned impaired bioavailability in plant-based diets, this is quite alarming. The estimated absorption rates are 15%–35% and 2.8% for heme and non-heme Fe, respectively [49]. Therefore, the consumption of heme Fe (meat and fish) together with enhancers of Fe absorption should be encouraged, since heme Fe is much more easily absorbed than non-heme Fe (most dietary iron), the absorption of which greatly depends on the balance between inhibitors and promoters. Liver is naturally low in fat and is a valuable source of micronutrients such as Zn and vitamins A, B, and D, as well as Fe [53]. Official recommendations dissuade pregnant women in the first and second trimesters as well as those who wish to become pregnant from consuming liver due to assumed teratogenicity for the fetus [56]. However, as there is no reason to refrain from moderate consumption of liver (20–50 g) during the third trimester, one portion every two weeks is recommended. In any case, even small amounts of meat, complementing a largely vegetable-based dish, can boost the availability of non-heme Fe, as the ―meat factor‖ has a positive effect on non-heme Fe absorption. This is gratifying when considering that Chinese lunch and dinner are commonly accompanied by at least some meat. However, the strongest promoter of non-heme Fe absorption is vitamin C from fresh fruits or vegetables. As the interaction takes place in the gastrointestinal tract, positive effects on non-heme Fe absorption are the greatest when promoters are consumed in the same meal. Hence, as an accompanying measure, the consumption of a glass of freshly pressed orange juice or a whole orange is recommended to improve the Fe absorption from plant foods. Vegetables high in vitamin C (bitter gourd, cauliflower, sweet peppers) or additionally in citric, malic and tartaric acid, such as potatoes, tomatoes, or cabbage are good alternatives for improving Fe absorption. A range of traditional food preparation

practices enhances the Fe absorption by reducing the levels of phytates in plant foods (fermentation, germination, milling, soaking and roasting) [53]. According to local food culture and the result of NutriSurvey, sesame seeds, soybean milk film, pumpkin seeds, and shitake mushrooms are recommended as Fe sources for both rural and urban women. Abalone (expensive seafood) could also be a good example of food rich in Fe.

Good sources of Zn include shitake mushrooms, sesame seeds, sunflower seeds, pumpkin seeds, red meat, liver, seafood, eggs, and dairy products. Grains and legume seeds also provide considerable amounts of Zn. However, efficiency of absorption is inversely related to the content of phytates [53].

2.5 Limitations of This Study

Due to lack of published evidence, food consumption patterns of the Deyang study were compared with the NNHS, which included a small sample from Sichuan province and a smaller sample of pregnant women in third trimester. This was the best possible comparison for the time being.

Dietary assessment is based on self-reported data that tend to under-or overestimate actual food consumption due to several reasons [64–69]. The pattern of sharing a meal and complexity of Chinese dishes make an accurate recall of the types and amounts of foods consumed more difficult. Another challenge of dietary assessment relates to the variability of food composition databases, and the need —to set global micronutrient recommendations based on harmonizing those from IOM, WHO/FAO [70] including Chinese DRIs adopted by INFSC 2002/2004.

Furthermore, a study design based on the single 24-h recall method is not suitable for estimating the proportion of the population that consumes adequate or inadequate diets, since a single 24-h recall is not representative of the long-term, usual intake of individuals due to high day-to-day variability [65,68,69,71]. However, the mean of one-day intakes by individuals drawn from a large, representative sample is not affected by day-to-day variations, thus the use of a single 24-h recall—representing an appropriate mix of the days of the week—was a good estimate of the group's usual mean intake [72]. Seasonal variations are not reflected in our study due to the cross-

sectional study design.

Research shows substantial variations in the amount of cooking oil added during food preparation across time, regional differences, and socio-economic status [73]; this variation discourages a definition for recipe standards. However, as the estimate of cooking oil consumption by every individual may lead to substantial under- or overestimation of fat intake, the generation of standard recipes is appropriate. Secondly, as we relied on recipe files, we could not address the problem of oil residues in cooking utensils as a major error source. This approach is substantiated when comparing the average oil amount consumed per capita day (46 g) with amounts reported in the 2002 NNHS including individuals of all ages (41 g) [20].

Another limitation is the fact that despite the random selection of medical institutions the results cannot be generalized for the total population of pregnant women in the study area. However, the percentage of the population covered by health insurance schemes in China increased from 22.1% in 2003 to 87.1% in 2008. In terms of rural areas, the coverage by the rural cooperative medical scheme (RCMS), which is heavily subsidized by national and local government, increased from 12.7% to 94.2% from 2003 to 2009 [74]. Between 2006 and 2010 the majority of Chinese women (96%) delivered in medical institutions [26]. Based on this additional information it can be assumed that pregnant women recruited from the hospitals constitute a good representation of the population of pregnant women in the study area.

2.6 Conclusions

Before conception, the prevalence of a low BMI was more pronounced in rural areas as compared to urban areas. Urban pregnant women had more desirable intakes in all nutrients (except for fat) than rural women but still had low intakes of certain micronutrients. A more balanced diet for pregnant women in the Deyang region could be achieved by serving non-fried rather than fried dishes, the partial substitution of lean meats for high-fat meats, increased consumption of seafood, more regular consumption of animal organs (in particular, liver), sufficient consumption of eggs, a more privileged position of tofu, whole grains, colorful fruits and vegetables, and low-fat dairy products in the daily diet. Adequate amounts of pulses, selected seeds or nuts make the balanced

diet complete. To conclude, in compliance with Ma [58], dietary diversification is suggested as the key intervention to improve the macro- and micro-nutrient intake of pregnant women living in Sichuan province. Succinctly, women are advised to limit cooking oil consumption as a major source of dietary fat, along with increasing nutrient-dense foods.

The great variety of culturally acceptable food choices is a decisive advantage in creating a diet that best fulfills the nutrient requirements of pregnant Chinese women. Most desirable would be improving nutritional status even before conceiving. Adherence to at least some of the recommendations given, with particular emphasis on nutrition education especially for pregnant women from rural areas, can narrow the nutrient gap considerably.

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2.8 Conflict of Interest

The authors declare no conflict of interest.

2.9 References

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Chapter 3

Breastfeeding practices on postnatal wards in urban and rural areas of the Deyang region, Sichuan Province of China

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3 Breastfeeding practices on postnatal wards in urban and rural areas of the Deyang region, Sichuan province of China

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Abstract

Background: Despite the efforts that have been made to promote breastfeeding in China since the 1990s, there is still a very low prevalence of exclusive breastfeeding. The objective of this study was to assess the current situation of infant feeding practices during the postpartum hospital stay in urban and rural areas of the Deyang region.

Methods: Cross-sectional sampling was used in two urban hospitals and five rural clinics in the Deyang region of southwestern China. Interviews with mothers after delivery (urban n = 102, rural n = 99) were conducted before discharge and five focus group discussions were held.

Results: The prevalence of Caesarean section was high in both urban and rural areas (63.9 % urban vs. 68.4 % rural). After birth, nearly all mothers (98.0 % urban vs. 99.0 % rural) initiated breastfeeding. One week after delivery, the prevalence of exclusive breastfeeding was 8.0 % (9.8 % urban vs. 6.1 % rural), almost exclusive breastfeeding 34.5 % (29.4 % urban vs. 39.8 % rural), mixed feeding 56.0 % (58.8 % urban vs. 53.1 % rural), and exclusive formula feeding 1.5 % (2.0 % urban vs. 1.0 % rural).

Breastfeeding initiation (≤ two days after birth) was positively associated (Odds Ratio [OR] 1.97, 95 % Confidence Interval [CI] 1.11, 3.50) with exclusive and almost exclusive breastfeeding, whereas birth length under 50 cm (OR 0.48, 95 % CI 0.26, 0.87), mother's education > 12 years (OR 0.46, 95 % CI 0.24, 0.88) and mother's lack of knowledge about the importance of colostrum (OR 0.35, 95 % CI 0.14, 0.86) were negatively associated with almost exclusive breastfeeding.

Conclusion: Although disparities between urban and rural areas exist, the situation of infant feeding is inadequate in both settings. The high prevalence of Caesarean section, the mothers' poor knowledge of the physiology of breast milk production, the mothers' lack of breastfeeding confidence, the widespread advertising of breast milk substitutes, and the changing perception of the function of breasts, may influence the unfavorable breastfeeding behavior observed in the study area.

Keywords: Breastfeeding, Exclusive breastfeeding, Birth outcomes, Local belief

3.1 Background

Policymakers in China have become aware of the importance of breastfeeding and have set clearly defined goals for the promotion of breastfeeding in The National Program of Action for Child Development in China [1–3] (infant breastfeeding of 80 % by 2000 and promoting exclusive breastfeeding [1]; infant breastfeeding of 85 % by 2010 [2]; exclusive breastfeeding up to six months to reach 50 % by 2020 [3]). Despite many efforts that have been made to promote breastfeeding in China since the 1990s [4–7], the actual situation is, nevertheless, lagging far behind the proposed goals.

One cohort study in northwest China in 2007– 2010 [8] showed that 96 % of the mothers with newborns initiated breastfeeding. The prevalence of exclusive breastfeeding was 24 % at 14 days after birth and 3 % at six months of age [8]. The prevalence of any breastfeeding at six months, 12 months and 24 months of age was 70, 30 and 2 % respectively [8]. In 2010, a breastfeeding study of 2354 children, conducted in central and western China (including Sichuan province), indicated that 29 % of infants under six months were exclusively breastfed, while 56 % of children at one year and 9 % of children at two years of age received their mothers' milk in addition to complementary feeding [9]. One special report by Harney about infant formula sales in China pointed out that the prevalence of exclusive breastfeeding at six months of age could be as low as 0.2 % in parts of China [10]. The national breastfeeding data in China (data from UNICEF, 2012–2014), shows the prevalence of exclusive breastfeeding under six months was 28 % with no increase over the last three years [11– 13]. Meanwhile, information about the proportion of young children who were breastfed up to two years of age is still not available [11– 13]. Alongside the low prevalence of exclusive breastfeeding and any breastfeeding in China in 2012, China had already become the world' s largest infant formula market with a marketing scale of 38.5 billion RMB (Chinese currency, 6.2 billion US dollars). The number of newborns was 16 million in 2012 [10, 14].

In 2015, the Chinese government published a new population policy stating that "all resident couples will now be allowed to have two children" [15]. This was the most important reformation of the one-child policy since 1979 [16]. In order to meet the challenges of the next peak birth

period in China brought about by the new "two child policy", and to reduce infant mortality and improve young children' s health, it is recommended that breastfeeding, rather than infant formula, should be promoted more vigorously [17, 18].

In Sichuan province, nearly 60 % of the people live in rural areas [19]. Recently, one study indicated that, in 2012 the mortality rate of infants (<1 year, per 1000 live births) in rural areas was more than double that in urban areas (5.2 in urban vs. 12.4 in rural) [20]. Malnutrition is closely correlated with child mortality [21], which could be prevented by optimal feeding. Many other Chinese studies have shown similar findings as the growth of rural infants and children was behind that of children living in urban areas [21– 24], while poor infant feeding practices (including suboptimal breastfeeding) were common in both areas [25– 28]. One study carried out in Sichuan determined that poor feeding methods, rather than limited food resources, caused the disparity between urban and rural children. Thus, culturally appropriate interventions are needed to close these health gaps between urban and rural children [23]. Until recently, limited data about feeding practices and related local beliefs had been published in the study area. Nevertheless, the feeding practice at the beginning of a newborn' s life is one of the key factors for successful breastfeeding. Consequently, the objective of this study became to assess the current situation of infant feeding practices in urban and rural areas of the Deyang region as the basis for the development of adequate nutrition and health education messages.

3.2 Methods

3.2.1 Infant feeding definitions

In this study, the following infant feeding definitions were used:

Exclusive breastfeeding (EBF): Breastfeeding only, with no other food or liquid, or water, with the exception of drops or syrups consisting of vitamins, mineral supplements or medicine. This means that the infant did not receive any type of prelacteal food and no supplementary food.

Almost exclusive breastfeeding (AEBF): The infant received prelacteal food before the onset of breastfeeding, but no supplementary food was offered after breastfeeding was established [29].

Mixed feeding: The infant was fed with breast milk, infant formula and/or other types of food.

Exclusive infant formula feeding: The infant was fed with infant formula, but without any breast milk.

3.2.2 Study design and sample

The Deyang region is located in the northeast of Chengdu Plain in Sichuan province (southwestern China). In 2011, it had a population of 3.9 million and 36,000 babies were born [19]; 57 % of the people live in rural areas, while the sex ratio (male: female) is 105.2 : 100 [19].

Based on the UNICEF data between 2008 and 2012, 99 % of Chinese women had access to an institutional delivery [13]. In this study, a cross-sectional sampling was used in two urban hospitals and five randomly selected rural clinics in the Deyang region of Southwestern China (Sichuan province). In 2012, 204 mothers with newborns were recruited consecutively on postnatal wards on the basis of informed consent. Interviews were conducted before discharge using a structured questionnaire. The place of origin, urban or rural, was defined as the permanent living area of the participants, but this could have been different from their birthplaces.

3.2.3 Data collection

The structured questionnaires for women admitted to postnatal wards until discharge included five parts: Part 1 recorded birth outcomes of the newborns and type of delivery; Part 2 assessed the initial infant feeding patterns; Part 3 consisted of mothers' perceptions about breastfeeding; Part 4 collected the mothers' anthropometric data (retrospectively) and gestational weight gain, and Part 5 covered the mothers' socio-demographic data.

3.2.4 Statistical analysis

Data on maternal characteristics, birth outcomes and breastfeeding practices were described using means (SD) and frequencies. Differences in maternal and newborn characteristics between urban and rural areas were assessed by the independent Student's t-test, Fisher's exact test or Pearson's

Chi-Square test, as appropriate. Logistic regression was applied to identify factors associated with exclusive/almost exclusive breastfeeding [29]. The following variables were assessed: Caesarean section, preterm birth (babies born alive before 37 weeks of pregnancy), sex of newborn, birth weight, low birth weight, birth length < 50 cm, time to initiating breastfeeding, mother's knowledge of the importance of colostrum, mother's attitude about the safety of infant formula, gestational weight gain, and mother's age, prepregnancy Body Mass Index (BMI), education, income, and place of origin (urban vs. rural). The significance level was defined as a p-value < 0.05; all statistical analysis was carried out using SPSS software (SPSS Inc., Chicago, IL; Version 20).

3.2.5 Qualitative study

In addition, in order to explore the social/cultural reasons influencing mothers' feeding practices, five focus group discussions (FGDs) with three to six local breastfeeding mothers and their infants were held in 2013. On the basis of informed consent, a total of 21 mothers were randomly recruited during their monthly child health care visits at one urban hospital. Questions about awareness of early initiation of breastfeeding, personal experiences of delay of the initiation of breastfeeding and the use of prelacteal food, reasons why the mothers could not breastfeed exclusively, factors that could help mothers to initiate breastfeeding, and reasons for infant formula preference were discussed in the FGDs. The discussions were recorded by digital voice recorder and transcribed onto computer later. NVivo 10 and Microsoft Word 2011 (Mac version) were used to analyze the transcripts. Thematic analysis was applied during the process of creating categories. After transcription and familiarization with the original data, initial codes were generated from the data answering the questions. Similar codes were classified into categories according to their themes. The final categories were reviewed and defined by two researchers. As a supplemental part of the data, results from FGDs were incorporated into the results and discussion part of this paper.

3.2.6 Ethical considerations

This study conforms to the provision of the 1995 Declaration of Helsinki (revised in Edinburgh,

2000) and was approved by the Medical Committee of Deyang City, China (dated: May 9, 2010).

3.3 Results

In 2012, a total of 204 mothers with newborns (urban n=102, rural n=99, missing value n=3) participated this study. Five focus group discussions (in total 21 mothers) were held in 2013.

Table 3. 1 Demographic and anthropometric characteristics of urban and rural mothers on postnatal wards

	Total n=201	**Urban** n=102	**Rural** n=99	**P-value**
Age, years	26.0 ± 4.2	26.9 ± 3.7	25.0 ± 4.5	0.001
Weight pre-pregnancy, kg	50.5 ± 6.8	51.1 ± 6.9	49.8 ± 6.7	0.193
Height, m	1.58 ± 0.05	1.59 ± 0.05	1.57 ± 0.05	0.006
BMI [a], pre-pregnancy, (kg/m^2)	20.35 ± 2.65	20.33 ± 2.54	20.36 ± 2.78	0.943
BMI <18.5, n (%)	42 (22.2)	21 (21.9)	21 (22.6)	
BMI 18.5~24.9, n (%)	137 (72.5)	71 (74.0)	66 (71.0)	
BMI 25~29.9, n (%)	8 (4.2)	4 (2.1)	4 (4.3)	
BMI ≥30, n (%)	2 (1.1)	0	2 (2.2)	
Parity	1.12±0.33	1.09±0.29	1.16±0.37	0.151
Education				
≤ 12 years (senior high school), n (%)	141(70.9)	55 (53.9)	86 (88.7)	<0.001
> 12 years (i.e. university or above), n (%)	58 (29.1)	47 (46.1)	11 (11.3)	
Monthly income, RMB [b]	2683 ± 2542	3074 ± 3086	2241 ± 1648	0.026

Values are mean ± SD or number (%)

P-value: independent-samples T test or Fisher's exact test

[a] BMI, body mass index (weight/squared height), categorized following WHO standard [35, 61]

[b] Chinese currency, 1 RMB=0.1622 US Dollar (2014.08.28)

3.3.1 Mothers' demographic and anthropometric status

Urban mothers gave birth at older ages, were taller, better educated and had a higher mean income than mothers from rural areas (Table 3.1).

Table 3. 2 Birth outcomes of urban and rural newborns

	Total n=201	**Urban** n=102	**Rural** n=99	**P-value**
Premature birth (<37 weeks), n (%)	4 (2.0)	4 (4.0)	0	
Term birth (37-42 weeks), n (%)	186 (93.5)	90 (89.1)	96 (98.0)	
Postmature birth (≥42 weeks), n (%)	9 (4.5)	7 (6.9)	2 (2.0)	
Gestational weight gain (GWG)[d], kg	15.7 ± 5.3	16.7 ± 5.2	14.6 ± 5.2	0.007
If BMI<18.5; GWG, kg	15.8 ± 5.5	18.4 ± 5.3	13.1 ± 4.3	
If BMI 18.5~24.9; GWG, kg	15.8 ± 4.9	16.1 ± 4.7	15.4 ± 5.0	
if BMI ≥25; GWG, kg	14.0 ± 9.9	16.3 ± 14.3	12.8 ± 8.4	
Type of delivery				
Vaginal delivery, n (%)	66 (33.0)	35 (34.3)	31 (31.6)	0.764
Caesarean section, n (%)	134 (67.0)	67 (65.7)	67 (68.4)	
Sex of newborns				
Girls, n (%)	119 (59.2)	58 (56.9)	61 (61.6)	0.566
Boys, n (%)	82 (40.8)	44 (43.1)	38 (38.4)	
Birth weight, kg	3.27 ± 0.40	3.32 ± 0.40	3.21 ± 0.39	0.053
Girls (n=119, 58, 61), kg	3.25 ± 0.39	3.27 ± 0.40	3.23 ± 0.37	0.607
Boys (n=82, 44, 38, kg	3.29 ± 0.41	3.39 ± 0.38	3.18 ± 0.42	0.021
Low birth weight <2.5kg, n (%)	6 (3.0)	3 (2.9)	3 (3.0)	-
Normal 2.5~4 kg, n (%)	188 (93.5)	95 (93.1)	93 (93.9)	
High birth weight ≥4kg, n (%)	7 (3.5)	4 (3.9)	3 (3.0)	
Birth length[c], cm	49.5 ± 1.5	49.8 ± 1.7	49.2 ± 1.4	0.005
Girls (n=114; 56, 58), cm	49.3 ± 1.4	49.4 ± 1.4	49.1 ± 1.5	0.280
Boys (n=78; 42, 36), cm	49.8 ± 1.7	50.3 ± 1.9	49.2 ± 1.2	0.005
Birth length < 50 cm [c], n (%)	79 (41.1)	32 (32.7)	47 (50.0)	0.019

Values are mean ± SD or number (%)
P-value: independent-samples T test or Fisher's exact test
[c] n=98 for urban and n=94 for rural newborn (total n=192); according to the *Growth standard of Chinese children under 7 years* [62], the median of length of male newborns was 50.4cm while the female newborns was 49.7cm. Normally Chinese doctors use *0-3 years growth chart*[63]to evaluating the development of the newborns, in which the minimum scale of length is 0.5cm. In order to simplify the process, 50cm has become a common cut off point for judgment.
[d] Recommendation for weight gain according to pre-pregnancy BMI: Underweight (BMI<18.5) 12.5-18kg; Normal range (BMI 18.5-24.9) 11.5-16.0kg; Overweight/Obese (BMI ≥25) 5-11.5 kg [64]

3.3.2 Birth outcomes

89.1% of the urban infants and 98.0% of rural infants were born at term (37-42 weeks, gestational age). Premature and postmature birth occurred more frequently in urban areas than in rural areas (see Table 3.2). Referring to the birth outcomes, urban girls were slightly heavier and taller than rural girls. However, the difference was not significant. By contrast to girls, urban boys were significantly heavier and taller than rural boys. The prevalence of low birth weight (<2.5 kg) was nearly the same in urban and rural areas, whereas high birth weight (≥4 kg) was more common in urban than rural areas (see Table 3.2).

3.3.3 Infant feeding practice on postnatal wards

The prevalence of different types of infant feeding on postnatal wards is illustrated in Table 3.3. Soon after birth, nearly all mothers (98.0% urban vs. 99.0% rural) started with any type of breastfeeding (received breast milk with/without other drink, formula or other infant food). Although only 89.1% (96.9% urban vs. 81.1% rural) of the mothers knew the term "colostrum", 94.4% (93.0% urban vs. 95.8% rural) of the postpartum mothers stated that their babies received it.

Only 8.1% of urban mothers and 5.2% of rural mothers could meet the requirement for "early initiation of breastfeeding within the first hour of life". Most of the mothers started breastfeeding at ≥ 2nd day post-partum (Table 3.4). Overall, results about initiation and onset of breastfeeding were similar among urban and rural mothers (p=0.092).

3.3.4 Exclusive/almost exclusive breastfeeding (EBF/AEBF)

Before the initiation of breastfeeding, 87.3% (86.0% urban vs. 88.7% rural) of the newborns were fed with pre-lacteal food. The most commonly used pre-lacteal food was infant formula (82.7% urban vs. 86.5% rural), followed by warm water (11.2% urban vs. 10.4% rural), sugar water (2.0% urban vs. 1.0% rural) and fruit juice. One urban baby was given fish liver oil as the first food.

After the establishment of breastfeeding, infant formula was fed to 47.9% (51.5% urban vs. 44.3%

rural) of the infants as a supplement to breast milk on the postnatal wards.

Therefore, due to the high prevalence of pre-lacteal feeding before the initiation of breastfeeding and the common use of supplementary food after beginning breastfeeding, the prevalence of exclusive breastfeeding in postnatal wards was only 8.0% (see Table 3.3). More urban women (9.8%) than rural women (6.1%) breastfed exclusively.

Table 3. 3 Type of infant feeding practiced by urban and rural mothers in postnatal wards

	Total n=200	**Urban** n=102	**Rural** n=98
Exclusive breastfeeding, n (%)	16 (8.0)	10 (9.8)	6 (6.1)
Almost exclusive breastfeeding, n (%)	69 (34.5)	30 (29.4)	39 (39.8)
Mixed feeding, n (%)	112 (56.0)	60 (58.8)	52 (53.1)
Exclusive infant formula feeding, n (%)	3 (1.5)	2 (2.0)	1 (1.0)

Table 3. 4 Distribution of time to start breastfeeding by urban and rural mothers

	Total n=196	**Urban** n=99	**Rural** n=97
Within 1 hour after birth, n (%)	13 (6.6)	8 (8.1)	5 (5.2)
1-6 hours after birth, n (%)	27 (13.8)	15 (15.2)	12 (12.4)
7-24 hours after birth , n (%)	14 (7.1)	8 (8.1)	6 (6.2)
2nd day after birth, n (%)	54 (27.6)	25 (25.3)	29 (29.9)
3rd day after birth, n (%)	54 (27.6)	20 (20.2)	34 (35.1)
4th day after birth or later, n (%)	34 (17.3)	23 (23.2)	11 (11.3)

Logistic regression analysis revealed that women who initiated breastfeeding within the first two days (≤2days) were more likely to breastfeed exclusively or almost exclusively (EBF/AEBF). By contrast, factors such as birth length <50 cm, higher educational level (>12 years), knowledge about the importance of colostrum, and Caesarean section reduced the likelihood of EBF/AEBF

(Table 3.5). Caesarean section was also associated with a lower proportion of mothers who initiated breastfeeding within two days (OR 0.489, 95%CI: 0.266-0.896; p=0.021).

Table 3. 5 Factors associated with exclusive (EBF) and/or almost exclusive breastfeeding (AEBF) in postnatal wards

Factors	OR	95% CI	P
Breastfeeding initiated ≤ 2 days	1.97	(1.11-3.50)	0.020
Birth length of newborns <50 cm	0.48	(0.26-0.87)	0.016
Mother's education > 12 years	0.46	(0.24-0.88)	0.019
Mothers have knowledge about the importance of colostrum	0.35	(0.14-0.86)	0.023
Caesarean section	0.55	(0.31-1.00)	0.051

OR, odds ratio (CI, confidence interval) for EBF and/or AEBF

Table 3. 6 The reasons for delay of initiation of breastfeeding given by mothers in Focus Group Discussions (FGDs)

Classified reasons	Representative quotes
Lack of knowledge about early initiation of breastfeeding	• *"The doctors and nurses didn't tell us to start breastfeeding immediately (after childbirth) The grandparents also didn't mention that. "*
No breast milk at the beginning	• *"Immediately after birth we had no idea that there would be some breast milk available soon after delivery"* • *"I could not see/feel any breast milk after delivery. Therefore, there was no milk ready to be sucked out."*
Caesarean section	• *"Because I had a Caesarean section, the wound was still painful after birth. Therefore, I started to breastfeed my baby on the third day after delivery"* • *"After the Caesarean section, we expressed a bit of colostrum for the baby by hand"*
Too big nipples	• *"The baby refused to suck, because the nipples were too big for him. About three days later, he was ready to start sucking."*

Table 3.7 Reasons for low prevalence of exclusive breastfeeding and preference for infant formula mentioned by mothers in FGDs (n=21)

Classified reasons	Representative quotes
Knowledge about EBF	• *"Many mothers never heard about exclusive breastfeeding."*
Amount of breast milk is not enough	• *"We know breast milk is the best, but we were afraid that the amount is not enough. We don't know when the baby is full."* • *"Because sometimes, if the breast milk is not enough, the baby will cry, so we give him infant formula in addition."* • *"I am afraid that my breast milk is not enough and consequently my baby will not grow/develop properly."* • *"I have no idea. I want to breastfeed exclusively, but the amount of my breast milk is not enough."* • *"Many of my friends in my generation didn't have breast milk after childbirth at all."* • *"In fact, most of the mothers are willing to breastfeed their babies because breast milk is the best. But there is no way to breastfeed exclusively, because their breast milk is not enough."*
Breast milk is not nutritious enough (influence of advertising)	• *"Probably the nutrient content in my milk is not enough. Therefore I use infant formula as supplement."* • *"Because infant formula has many advantages, it is rich in some nutrients like DHA (docosahexaenoic acid), taurine that are good for baby's development. But the content of these nutrients is low in mothers' milk."* • *"Infant formula preference is often influenced by advertising for it everywhere."*
Necessary to add water	• *"Someone with experience told us water is necessary besides breast milk."*
Parents' psychology affection	• *"As we only have one child, all parents cherish their babies and worry too much that their baby may get hungry."* • *"Everyone treasures the baby so much and thinks that with infant formula the baby will develop better. Many mothers believe that 'infant formula is necessary in addition to breast milk.'"* • *"The feeling that "all the other babies are fed with infant formula" makes mothers think it is wrong if they don't give infant formula to their own babies. Mothers are afraid of the development of their babies falling behind others."*
For mothers' good figure	• *"Mothers choose infant formula instead of breastfeeding for the shape of their breasts; it's a common problem. Anyway，I don't care about my figure, I will insist on breastfeeding."* • *"At present, mothers have different perceptions. Some mothers do not want to breastfeed, just like my friend who believes breastfeeding is harmful for her figure. "*
For convenience	• *"Some mothers are using infant formula for convenience."* • *"The babies fed with infant formula will not be hungry easily. Their mothers do not need to wake up and feed the babies so frequently in the night. It's more convenient. "*
Wound pain after CS	• *"It's painful after Caesarean section. It may influence exclusive breastfeeding (hard to hold the baby)."*

To understand the reasons for widespread delay of the initiation of breastfeeding and the low prevalence of exclusive breastfeeding as well as the high use of infant formula FGDs were conducted (Table 3.6 and Table 3.7). Many mothers had never heard about starting breastfeeding within one hour after childbirth and a number of mothers believed that the secretion of breast milk wouldn't start immediately after birth. Several mothers explained that after Caesarean section, it would be difficult to get the right breastfeeding position soon because of pain at the site of the incision. Furthermore, nipple problems were also believed to be one of obstacles to early initiation of breastfeeding (Table 3.6). Regarding exclusive breastfeeding, first and foremost, insufficient and inadequate knowledge, but also external influences, such as societal expectations and the pressure of advertising were found to be the major factors accounting for the study findings. Altogether, they contributed to a mother´s feeling of inadequacy. Many women doubt their capability to nourish their babies, others fear that breastfeeding is harmful for the shape of their breasts (Table 3.7).

3.4 Discussion

3.4.1 Disparities between urban and rural areas

Over the past two decades, China has made substantial progress in maternal health [20], and the gap between urban and rural maternal mortality is closing (in 1991: 46 urban vs. 100 rural maternal deaths per 100.000 live births; in 2012: 22 urban vs. 26 rural respectively [30]. However, the National Maternal Mortality Surveillance System in China (NMMSS) reported that between 2001-2005 the risk ratio of preventable maternal mortality in rural areas had doubled compared to urban areas (OR 2.38, 95%CI: 2.01-2.81) [31]. According to the results of this study, some of the disparities in social, demographic and anthropometric status between urban and rural mothers still existed in the study area. On average, urban mothers had significantly higher incomes, were better educated and were about two years older when they conceived than were rural mothers (see Table 3.1). One study in rural western China indicated that the age of the woman was positively correlated with anemia and that the higher the wealth index of the household, the lower the prevalence of maternal anemia [32]. NMMSS reported that, in remote rural areas, preventable

maternal mortality accounted for 97% of maternal deaths, while the most frequent factors were associated with mothers' lack of adequate knowledge [31].

Referring to the mothers' anthropometric status before pregnancy, in this study, urban mothers were two centimeters taller than rural mothers. Potentially, this may have influence on birth outcomes, the type of delivery, as well as the type of infant feeding, all of which will be discussed later in this paper. Most of the mothers in both areas had a pre-pregnancy BMI within the normal range. Slightly more mothers tended to be underweight or overweight/obese in rural compared to urban areas. This study found that the proportion of underweight mothers was high in both urban and rural areas (21.9% urban vs. 22.6% rural), while the prevalence of overweight/obesity was relatively low in both areas (2.1% urban vs. 6.5% rural). This finding is in line with the results from another cross-sectional study in the same region [33], and with a study conducted in northeastern parts of China by Liu et al. [34]. By contrast, Pei et al. [35], found a relatively low prevalence of maternal underweight (7.9%) and a comparably higher prevalence of overweight/obesity (17.9%) in rural Sichuan province.

With respect to birth outcomes, urban newborns were significantly taller and heavier than rural infants in the study area, which could be explained by the fact that the urban mothers were taller and gained more weight during pregnancy than rural mothers. The prevalence of low birthweight in the study area was 3%, which was consistent with the Chinese national level [13], with no significant difference between urban and rural areas. Although the problems of low birthweight and high birthweight infants were not serious in the study area, since pre-pregnancy underweight is known to be associated with poor birth outcomes (i.e., premature birth, low birthweight) [34], more attention needs to be paid to urban and rural underweight women in reproductive age, especially for rural underweight pregnant women as recommended by Gao et al. [33].

This study found that, soon after childbirth (3-5 days), nearly all mothers had started breastfeeding (98.0 urban vs. 99.0% rural) in the Deyang region. Similar results were found by Qiu et al., any type of breastfeeding being practiced substantially in both city (96.5%) and rural areas (97.4%) [36], by Tang et al. (93.5% rural) [25] and by Guo et al. (98.3% in total) [9]. However, with reference to exclusive breastfeeding before discharge, the prevalence of EBF was extremely low

in both urban (8.1%) and rural areas (5.2%), as compared to hospital-based studies by Qiu et al. (38.0% urban vs. 61.0% rural) [36]. Although in this study, no significant difference in infant feeding in urban and rural areas was found on postnatal wards, the situation was inadequate in both settings (see Table 3.5). It is clear, therefore, that there must be other factors impacting mothers' infant feeding practices, an issue that will be discussed below.

3.4.2 Initiation of breastfeeding

In this study, only 6.6% of the mothers initiated breastfeeding within one hour after delivery. This finding was a bit lower, but similar to the results by Tang et al. (9.1%) [27] and Lou et al. (11.1%) [37] in the same region of Sichuan province. This is in line with the fact that local people in Sichuan lack the knowledge (only 26.5% undergraduates agreed) that "breastfeeding should be started within the first hours after birth" [38]. However, when looking at the results of a broader regional study [9], 6.6% was far behind the 59.4% level in central and western China.

"Why did the mothers delay the initiation of breastfeeding?" was a question discussed in the FGDs (see Table 3.6). A "lack of knowledge about early initiation of breastfeeding" and "Caesarean section" were given as the main reasons. Both quantitative and qualitative results reflected that: (a) there is a need to improve the implementation of the "Ten Steps to Successful Breastfeeding" [39], both in urban hospitals and rural clinics in the study area and (b) it could be explained by a misunderstanding of what "initiate breastfeeding" means in the local area. In the study area, "initiate breastfeeding" does not have the same meaning as "start sucking". The mothers insisted they would not start breastfeeding until they felt that they had breast milk or that their breasts were engorged, even if the baby had started sucking (breastfeeding) several hours or even a few days earlier. This misunderstanding may partly explain why the study results for EBF were so low as well.

3.4.3 Exclusive breastfeeding

Due to the widespread delay in breastfeeding, pre-lacteal feeding and the use of infant formula as a supplement to breast milk, the prevalence of EBF was only 8% on postnatal wards. This situation

was worse than the results of Chinese regional studies 28.7% [9], 24.2% [8] and at the national level 28.0% [13]. Ignoring the influence of pre-lacteal feeding, the prevalence of EBF/AEBF could be up to 42.5% in this study.

When the newborns' lengths were shorter than 50 cm, their chances of being breastfed (almost) exclusively were lower compared to those who were ≥50 cm. In other words, if the mother had borne a smaller sized baby, her confidence in being able to breastfeed exclusively was weaker. Based on these findings, nurses and midwives should offer more breastfeeding support to the mothers with smaller sized infants, because these infants could benefit very significantly from the higher bioavailability of nutrients in breast milk compared to infant formula [40, 41].

In this study, the time to initiate breastfeeding ≤two days after delivery was also significantly correlated with EBF/AEBF. The earlier the mothers started breastfeeding, the more likely they were to breastfeed exclusively. Although Caesarean section (CS) was found to be associated with EBF/AEBF, but indirectly, it was related to the time of initiating breastfeeding. Many other studies noted that CS delays the initiation of breastfeeding [42, 43] and is associated with the use of supplements among newborns [44] and mothers who had CS experienced more breastfeeding problems [45, 46]. Similar to earlier findings in the same study area [47], the proportion of CS was over 60% in this study area, CS could, accordingly, be defined as one of the risk factors for not exclusively breastfeeding. Thus, further work/research to reduce CS in China would be important.

Unexpectedly, both the mothers' educational levels and their knowledge of colostrum were negatively correlated with their feeding practices. Those findings were similar to some study results in other countries [48-50]. In focus group discussions, the mothers' knowledge of the definition of exclusive breastfeeding was found to be poor. Several mothers had no idea what exclusive breastfeeding meant (Table 3.7) or had mentioned a too long or too short duration of exclusive breastfeeding. Other wrong information included "besides breast milk, water is necessary" and "exclusive breastfeeding is good, but difficult to practice".

According to the results of the FGDs (Table 3.7), one misunderstanding revealed was that "there

was no/too little breast milk available immediately after childbirth". This was a common perception by mothers, grandparents, peers, and even some of the medical staff. Due to this misunderstanding, many expectant mothers had purchased one box of infant formula and brought it to the hospital before childbirth. It could also explain why more than 80% of the infants got infant formula as a pre-lacteal feed. This misunderstanding was also related to the delay in the initiation of breastfeeding, as the mothers believed that there was nothing in the breasts at the beginning and, therefore, they needed to wait until they were engorged or when they felt they had started to have breast milk. However, although mothers cannot see or feel it, there is at birth, already colostrum, which newborns receive when they suckle. In addition, the local belief that "water is essential as the first drink for newborns" was frequently mentioned by mothers in focus group discussions. This misunderstanding needs to be corrected during local breastfeeding promotion sessions.

Mothers tried to explain the low prevalence of exclusive breastfeeding in China during the FGDs (see Table 3.7). Obviously, the feeling that "the amount of breast milk produced was not enough" was one of the major reasons mentioned. In other studies, "insufficient breast milk syndrome" has also been considered an important barrier to successful breastfeeding [37, 51, 52]. Because mothers usually cannot measure the amount of breast milk a baby has drunk, the mothers in our study often lacked confidence about whether their babies were satisfied or wondered if they were still hungry. In order to match the requirements of the growth charts at the monthly child care examination, these mothers preferred giving additional infant formula to their babies after breastfeeding. In most cases, monitoring the amount and color of the urine in the diaper and the frequency of bowel movements is a more effective indicator than mothers' feelings [37]. Daily weighing of the infant in the hospital and every couple of days after discharge could reassure the mothers and improve their confidence about exclusive breastfeeding. Due to the fact that most of the mothers delayed the initiation of breastfeeding, pre-lacteal feedings were widely used. Supplementation was continued after initiating breastfeeding because of the fear of not producing enough milk. During the course of this study, it became obvious that the physiology of breast milk production was not clearly understood. Thus, education on the physiology of breast milk production and secretion and the related importance of frequent suckling should be included in

the maternal school curriculum.

Due to the widespread inappropriate advertising for infant formula in China [53, 10], parents believed that many health benefits are linked to formula feeding. Perceptions, such as infant formulas being as nutritious or even superior to breast milk, influenced several mothers to offer these formulas as supplements in addition to breastfeeding. To reduce the impact of the unsubstantiated health claims of the infant formula companies [54] the Ministry of Health of China already issued a ban on aggressive advertising of infant formula in 1995 [55]. However, due to lack of control mechanisms, the ban has not been effective.

Another barrier to exclusive breastfeeding in China is the shifting attitude about breasts among modern young people. Historically, the main function of breasts was simply feeding. People perceived "small and exquisite breasts" as beautiful [56]. According to traditional Chinese culture, small feet but not breasts were the important sexual organs [56-58]. However, in contemporary China, the role of breasts as a sexual stimulant is surpassing its feeding function, just as in other industrialized countries [59, 57, 60]. More and more mothers and their husbands choose infant formulas instead of breastfeeding, because they believe breastfeeding could cause mothers' breasts to shrivel or sag. To solve this increasing problem, mothers need a better understanding of the physical structure and the function of breasts through improved breastfeeding education. The mainstream media should take responsibility for highlighting maternal aspects of breastfeeding rather than focusing only on the erogenous function of breasts.

3.4.4 Limitations

It is likely that women who delivered their babies vaginally, without any complications, were discharged earlier and, consequently, were not included in our postnatal assessment which took place during the first week after delivery. Therefore, women who delivered their newborns by Caesarean section may be overrepresented by comparison to those who delivered without any complications and left the hospital earlier. In addition, the traditionally dominant role of family members (i.e. father, grandmother) with regard to infant feeding recommendations was not adequately considered in this study. It could have been useful in explaining the unfavorable

breastfeeding situation in the study area.

3.5 Conclusion

Although disparities in infant feeding between urban and rural areas exist, the situation is inadequate in both settings. The extremely low prevalence of exclusive breastfeeding among newborns was found to be associated with delayed initiation of breastfeeding and widespread use of infant formula in addition to breastfeeding. Directly and indirectly, the high prevalence (67%) of Caesarean section, the mothers' poor knowledge of the physiology of breast milk production, the misleading information in the aggressive advertising of infant formula as well as the shifting perception of the primary function of the breasts by modern people have led to a unfavorable breastfeeding status in the study area. At hospital level, the implementation of the "Ten Steps to Successful Breastfeeding" needs to be strengthened in both urban and rural areas. Nationally, effective systems for monitoring the ban on inappropriate advertising of infant formula are necessary. At the same time, the mainstream media should also take responsibility for breastfeeding promotion. Furthermore, exploring the reasons for high Caesarean section rates in the local area and methods of prevention would be another important research field.

3.6 List of abbreviations

WHO World Health Organization

FGDs Focus group discussions

BMI Body mass index

GWG Gestational weight gain

EBF Exclusive breastfeeding

AEBF Almost exclusive breastfeeding

NMMSS National Maternal Mortality Surveillance System in China

3.7 Competing interests

The authors declare that they have no competing interests.

3.8 Authors' contributions

HG, VS and EH designed this study. HG collected and analyzed the data, and drafted the first manuscript. QW helped with study design, organization of fieldwork and bibliographic searching. EH and VS were the BF counselors of this study and had worked on the paper, drafting and revising it. WS supported through data analysis and presentation of the results part of this study. CS contributed to bibliographic searching and paper revising. HKB was involved in the general study set up and proofreading.

All authors read and approved the final manuscript.

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Chapter 4

Association of Cesarean sections with mothers' socio-demographics, anthropometrics and perceptions in urban and rural areas of the Deyang region, Sichuan Province of China

4 Association of Caesarean sections with mothers' socio-demographics, anthropometrics and perceptions in urban and rural areas of the Deyang region, Sichuan province, China

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Abstract

Objectives: The decision for a Cesarean section (CS) is not only related to medical or obstetrical issues, but the maternal nutritional status and social/cultural factors can also influence the type of delivery. The objective of this study was to explore socio-demographic and anthropometric factors associated with the prevalence of CSs in the study area.

Methods: In 2012, 203 pairs of mothers and newborns were recruited, with informed consent, in postnatal wards in two urban hospitals and five rural clinics in the Deyang region of China. Face-to-face interviews were conducted on birth outcomes and the mothers' anthropometric and socio-demographic data within one week after delivery.

Results: The high prevalence of CS (67%) was positively associated with the mother's education and age as well as gestational weight gain. However, it tends to be negatively correlated with the mother's height (p=0.063). The main reason for CS as explained by mothers included complications before/during delivery, other medical conditions, and purposeful choice of CS by mothers (due to sociocultural factors, etc.).

Conclusions: Education about the complications and disadvantages of CS needs to be strengthened in the study area. Both the short-term (such as GWG) and long-term nutritional status (such as height) of the mother can affect the type of delivery. In addition to pre-pregnancy body mass index (BMI), it is recommended to expand the sample size to study the significance of height as an independent factor for designing the GWG guidelines for Chinese mothers.

Key words

Cesarean section, maternal height, gestational weight gain, sociocultural factors

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Author contributions

HG contributed the conception and design, fieldwork, data analysis and interpretation, preparation of the draft manuscript, and revisions. WS helped with data analysis, providing critique and revisions. QW provided support in the organization of the fieldwork. EH did language revisions and EJK provided critique. VS supervised the entire study, provided critique and made revisions. All authors read and approved the final manuscript.

4.1 Introduction

Originally, a Cesarean section (CS) was conducted to save the lives and health of mothers and newborns when unexpected problems, such as transverse presentation and obstructed labor etc. occurred during delivery [1, 2]. Nevertheless, over the last several decades, CS has become increasingly common worldwide, although most are undertaken without clear medical indications [3]. According to the WHO recommendation, the CS prevalence should be below 15% [3, 4]. However, the latest UNICEF report showed that the regional prevalence of CS in East Asia and the Pacific area was 32% and in China 41%[5]. From 2008 to 2014, the average annual rate of CS in China increased by 1%. There were significant differences in CS rates in different areas [6]. In 2014, a much higher prevalence of CS (57%) was found in Chengdu [6], the capital city of Sichuan and the neighboring area of Deyang region.

According to the World Health Organization (WHO), a CS rate above 10 to 15% at national level is unlikely to further reduce maternal and newborn mortality [1, 3, 4]. On the contrary, medically unnecessary CS may increase short and long-term health risks for both the mother and her newborn child [7, 8]. In 2015, WHO introduced the Robson classification [9] to assess CS trends worldwide. It adopted epidemiological parameters, such as obstetric history, the onset of labor, fetal presentation, the number of neonates etc. as control factors for the prevention of CS. However, an impressive body of literature has demonstrated that CS is not only a medical/obstetrical issue, but is also related to social and cultural factors [10].

From the perspective of nutritional science, several studies have indicated that maternal nutritional status can influence birth outcome and type of delivery [11-13]. Controlling gestational weight gain (GWG) is one of the widely recommended methods to prevent CS [14]. The Chinese diet is currently undergoing a transition from a traditional plant-based diet to a high-calorie animal-based way of eating. [15, 16], and there is a double burden of nutrient deficiencies and overweight/obesity in maternal nutrition [15, 17, 18]. However, the guidelines for preventing over- and underweight during the reproductive period are not yet well-established in China[14]. Studies in other countries have indicated that maternal height (especially short stature) might have an impact on GWG and thus affects the prevalence of CS [11, 19-21]. Until now there has been no relevant research in this field in China.

Based on the situation described above, the objective of this study was to further explore socio-demographic and anthropometric factors associated with the prevalence of CS, thereby, providing basic knowledge for prevention of medically unnecessary CS in China's Deyang region.

4.2 Methods

4.2.1 Study design and population

The Deyang region is located in the northeast of the Chengdu Plain in Sichuan Province, southwestern China. In 2011, it had a population of 3.9 million and 36,000 babies were born there. 57 % of people live in rural areas [22]. Based on the United Nations International Children's Emergency Fund (UNICEF) data between 2008-2012, 99% of Chinese women had access to an institutional delivery [23]. Two major urban hospitals and 5 rural clinics (randomly selected from the 11 rural communities of the Jingyang District in Deyang region) became sampling locations. Cases with severe birth defects, multifetation or separation of mother and newborn (due to health reasons) were excluded from the study. In 2012, 203 mothers with newborns were recruited consecutively on postnatal wards on the basis of informed consent. Face-to-face interviews were conducted before discharge, using a semi-structured questionnaire.

4.2.2 Data collection

The semi-structured questionnaires for women admitted to postnatal wards until their discharge included information on birth outcomes of the newborns, type of delivery, the initial infant feeding patterns, the mothers' anthropometric data (weight before conception), gestational weight gain, and the mothers' socio-demographic background. In the interview, an open-ended question "Why did you have a Cesarean section?" was asked to better understand the personal experiences and feelings of mothers who had had a CS.

4.2.3 Statistical analysis

Data on maternal characteristics and birth outcomes were described using number (frequency or prevalence), median (25%, 75% percentile), and mean (SD). Data of women who had a VD vs. those who had a CS were compared using the Pearson Chi-Square test, the Mann-Whitney U test or the t-test, as appropriate. Binary logistic regression was applied to identify factors (e.g. mother's height and pre-pregnancy BMI, gestational weight gain, the mother's age and her education etc.) associated with CS. The significance level was defined as a $p<0.05$; all statistical analysis was carried out using SPSS software (SPSS Inc., Chicago, IL; Version 20).

4.3 Results

4.3.1 Basic information

A total of 203 mothers with newborns participated in this study. On average, the prevalence of CS was 67.0% (urban 65.7% vs. rural 68.4%, $p=0.764$). Generally, the mothers who underwent CS were better educated, older, shorter and had higher gestational weight gain than those with vaginal delivery (VD), but no obvious difference in monthly income, pre-pregnancy weight and BMI was found. The newborns delivered by CS were slightly heavier and significantly taller than natural born ones. Parity, gestational age, prevalence of premature birth and sex of newborns were similar among CS and VD mothers (see Table 4.1).

Table 4. 1 Sociodemographic characteristics and birth outcomes of women who had a vaginal delivery (VD) vs. Caesarean delivery (CS) †

Variable	Total	VD	CS	P-value ‡
	n=203	n=68	n=135	
Place of origin [a]				0.687
Urban	102 (51.0)	35 (53.0)	67 (50.0)	
Rural	98 (49.0)	31 (47.0)	67 (50.0)	
Education[a, #]				0.047
Primary education or less	2 (1.0)	0 (0)	2 (1.5)	
Junior high school	60 (29.9)	21 (31.3)	39 (29.1)	
Senior high school	81 (40.3)	34 (50.7)	47 (35.1)	
Junior college/bachelor or above	58 (28.9)	12 (17.9)	46 (34.3)	
Age (years) [b]	25 (23, 28)	24 (22, 27)	26 (23, 29)	0.033
Monthly income (RMB) [§, b]	2000 (1800, 3000)	2000 (1500, 3000)	2000(2000, 3000)	0.185
Height, pre-pregnancy (cm) [c]	158.0 (4.8)	158.9 (4.7)	157.6 (4.9)	0.067
Weight, pre-pregnancy (kg) [c]	50.4 (6.8)	50.2 (6.0)	50.6 (7.2)	0.726
BMI, [¶] pre-pregnancy (kg/m^2) [c]	20.3 (2.7)	20.0 (2.3)	20.5 (2.8)	0.184
BMI classification, n (%) [a]				0.439
BMI <18.5 kg/m^2	44 (22.9)	15 (23.4)	29 (22.7)	
BMI 18.5~24.9 kg/m^2	138 (71.9)	48 (75.0)	90 (70.3)	
BMI 25~29.9 kg/m^2	8 (4.2)	1 (1.6)	7 (5.5)	
BMI ≥30 kg/m^2	2 (1.0)	0 (0)	2 (1.6)	
Parity, n (%) [a, #]				
Nulliparous	174 (87.4)	62 (92.5)	112 (84.8)	0.122
Parous	25 (12.6)	5 (7.5)	20 (15.2)	
Gestational weight gain (kg) [b]	15.0 (12, 18.5)	14.0 (11.0, 18.5)	15.3 (13.0, 18.6)	0.100
Birth weight (grams)[c]	3266 (395)	3214 (375)	3292 (404)	0.189
Low birth weight <2 500 g, [a]	6 (3.0)	3 (4.4)	3 (2.2)	0.116
Normal 2500~3999 g, [a]	190 (93.6)	65 (95.6)	125 (92.6)	
High birth weight ≥ 4000 g, [a]	7 (3.4)	0 (0)	7 (5.2)	
Gestational age, [a]				0.612
Premature birth, <37 weeks	4 (2.0)	2 (2.9)	2 (1.5)	
Term birth, 37-42 weeks	188 (93.5)	62 (91.2)	126 (94.7)	
Postmature birth, ≥42 weeks	9 (4.5)	4 (5.9)	5 (3.8)	
Newborn sex, [a]				
Girl	121 (59.6)	41 (60.3)	80 (59.3)	0.887
Boy	82 (40.4)	27 (39.7)	55 (40.7)	
Birth length (cm) [c, #]	49.5 (1.5)	49.2 (1.4)	49.7 (1.6)	0.037

† Data are number (prevalence)[a], median (25%, 75% percentile)[b], and mean (SD)[c], as appropriate

‡ P- values are Pearson Chi-Square (for prevalence) and significant difference (2-tailed) of independent t-test or Mann Whitney U-test, as appropriate

§ Chinese currency, 1 RMB=0.1622 US Dollar (2014.08.28)

¶ BMI, body mass index (weight/squared height), categorized following WHO standard [24, 44]

n=198 for gestational weight gain, n=194 for maternal height, n=201 for mothers' education, and n=196 for mother's age

4.3.2 Factors associated with the risk of CS

Binary logistic regression indicated that several factors played a role in the prevalence of CS (see Table 4.2). For mothers with a gestational weight gain higher than 15 kg, the likelihood of delivering by CS was nearly doubled, compared to mothers with a gestational weight gain of < 15kg, p=0.034 (OR 1.900, 95%CI: 1.050-3.440). Furthermore, the chance of a CS could be doubled by mothers with a height of <158 cm compared to the mothers who were taller than 158cm (OR 1.810, 95%CI: 0.969-3.383, p=0.063). In addition to the anthropometric factors, mothers' educational levels and age at childbirth were considered to be related to the occurrence of CS (see Table 4.2).

Table 4. 2 Likelihood of Caesarean section versus vaginal delivery †

Factors	Vaginal delivery	Cesarean section	Crude OR (95% CI) for Cesarean section	P-value
Gestational weight gain, ‡ [a]				
<15 kg	38 (55.9)	52 (40.0)	1	
≥15 kg	30 (44.1)	78 (60.0)	1.900 (1.050-3.440)	0.034
Maternal height, & [a]				
≥158 cm	43 (67.2)	69 (53.1)	1	
<158 cm	21(32.8)	61(46.9)	1.810 (0.969-3.383)	0.063
Mothers' education [a]				
Senior high school or less	55 (82.1)	88 (65.7)	1	
Junior college/bachelor or above	12 (17.9)	46 (34.3)	2.396 (1.167-4.918)	0.017
Mother's age §, [a]				
<28 years old	51 (79.7)	87 (65.9)	1	
⩾28 years old	13 (20.3)	45 (34.1)	2.029 (1.000-4.116)	0.050

[a] number (prevalence)

† binary logistic regression analysis, data are number (prevalence)[a]

‡ 15 kg was the median gestational weight gain of the samples.

& 158 cm was the median.

§ 28 years was the 75th percentile.

n=198 for gestational weight gain, n=194 for maternal height, n=201 for mothers' education, and n=196 for mother's age

Table 4. 3 Gestational weight gain (GW) according to mothers' pre-pregnancy BMI classification [45]

	Total n=189	Urban n=96	Rural n=93	Recommended range, kg†
Gestational weight gain (kg)[a]	15.6 (5.3)	16.7 (5.2)	14.6 (5.2)**	
Pre-pregnancy BMI, [a]				
Underweight (BMI <18.5) n= 42, 21, 21	15.8 (5.5)	18.4 (5.3)	13.1 (4.3)	12.5~18
Normal range (BMI 18.5~24.9) n= 137, 71, 66	15.8 (4.8)	16.1 (4.7)	15.4 (5.0)	11.5~16
Overweight/ Obese (BMI ≥25) n= 10, 4, 6	14.0 (9.9)	16.3 (14.3)	12.8 (8.4)	5~11.5

[a] Data are mean (SD);

** P=0.007 (independent t-test, rural vs. urban);

† WHO standard [24, 25], IOM recommendation for weight gain[40]

In order to explore the effectiveness of the current guidelines for GWG in preventing CS in China, the GWG of urban and rural women were analyzed according to the WHO standard [24, 25], mothers' pre-pregnancy body mass index (BMI) was classified into three groups: underweight (BMI <18.5 kg/m^2); normal range (BMI 18.5~24.9 kg/m^2); Overweight/Obese (BMI ≥25 kg/m^2). The results showed that women in urban areas had a mean weight gain exceeding the upper limit of the recommended range by the Institute of Medicine (IOM) (see Table 4.3).

4.3.3 Mothers' perceptions

The mothers who underwent a CS were asked an open-ended question "Why did you have a Cesarean section?". 57 of the 134 cesarean mothers explained their reasons (descriptive answers, see Table 4.4). Complications occurring before/during delivery were the most commonly mentioned reasons (26/57), followed by the unexpected date of delivery (13/57), the mother herself asked for a CS (9/57), and unsuitable medical condition of the mothers (9/57).

Table 4. 4 Reasons for CS as explained by mothers on postnatal wards

Reasons	Total n
Number of mothers who explained reason for Cesarean section	57
Complications occurring before/during delivery	
Hypamnion (insufficient amniotic fluid)	8
Breech presentation/ malposition	6
Umbilical cord around the fetus' neck	4
Cervix did not open	2
Placenta previa	2
Fetal macrosomia	2
Amniotic fluid contaminated	1
Cephalopelvic disproportion	1
Medical condition of the mother	
Cholestasis	2
Hypertension	2
After exfetation surgery (ectopic pregnancy)	1
Elderly parturient women	1
Hyperthyroidism	1
Post-retinal detachment surgery (risk to the eye due to the exertion of giving birth vaginally)	1
Previous Cesarean section	1
Unexpected date of delivery	
Premature birth	1
Past the expected date of birth/post-term birth	12
The mother herself asked for a Cesarean section	9
Total number of mothers with Cesarean section (frequency/total)	134/200

4.4 Discussion

4.4.1 Mothers' demographic factors related to CS

The strong popularity of institutional delivery in China has enabled mothers in both urban and rural areas to access adequate medical services. Great improvements in maternal health services across the country [26] and the expansion of maternity insurance coverage [27, 28] make the cost

of childbearing affordable. This could explain why the mothers' region of residence (urban vs. rural) and their household per capita income were not found to be associated with the occurrence of CS in this study.

The average level of education for CS mothers was significantly higher than that of mothers who had VD. Better education often means higher levels of economic independence and self-awareness, which allows mothers to have more freedom of choice. Better education also means a better understanding of the risks of CS and the benefits of natural delivery. But more highly educated mothers have frequently opted for CS, which goes against people's understanding of their high cognitive abilities. This showed that there were other factors beyond the rational cognition of mothers when they decide whether to choose a CS.

The average age of mothers who underwent CS was higher than that of mothers who had VD. The association between maternal age and type of delivery have been identified in many studies [10, 29, 30]. The risk of dystocia usually increases with the age of the mother [31], and this trend is more pronounced in nulliparous women than in parous women [32]. Since the second-child policy was not fully implemented at the time of this study, 87.6% of the mothers were nulliparous. If the mother's age was ≥ 28 years, the likelihood of having a CS doubled compared to those who were younger than 28. The average age of the new mothers in this study was 26 years. It is of practical significance to use the age of 28, the 75% percentile of childbearing age of local women, as a reminder of CS for nulliparous women.

4.4.2 Mothers' anthropometric data and birth outcomes related to CS

There is a correlation between a mother's height and whether she has a CS [11, 20, 21]. Mothers of short stature have a higher risk of cephalopelvic disproportion[21], and the risk of cephalopelvic disproportion may be exacerbated by differences in growth environment and nutrition between the two generations of mothers and children [11]. Mothers with CS tended to be shorter on average than that of VD mothers (p=0.067.) When using the median "158 cm" as the cutoff, a mother, who was <158 cm, was more likely to experience a Cesarean section than a mother who was taller than 158 cm (p=0.063). From the perspective of the length of the newborn,

this study found that babies born by CS were, on average, 0.5 cm taller than babies born by VD, and this difference was significant. To sum up, compared with VD mothers, the CS mothers in this study were relatively shorter, while their children had higher birth lengths. Body height is an indicator of long-term nutritional status. It can be inferred that, due to the improvement of the living environment and nutritional intake in their later stage, mothers of short stature, especially those who had largely increased their food intake during pregnancy, will have a higher risk of CS. This finding supports the theory of the difference between mother and child generations by Zaffarini E. et al [11]. This phenomenon can also be explained by general psychological logic. To have a taller child, a mother of short stature might attach more importance to nutritional intake or even excessive food intake during pregnancy. It follows that the nutrition and weight gain of mothers of short stature need more attention during pregnancy.

Unlike other research findings [29, 30], since the universal two-child policy had not yet been announced in China during the period of data collection for this study, the average parity was close to 1 and it was not significantly associated with the type of delivery. The situation of gravidity was similar to parity in this study. Therefore, the influence of a previous CS on the decision-making for the type of delivery cannot be considered in this study.

With respect to the sex of the newborn, some studies showed that mothers of male infants were more likely to undergo a CS than those of female newborns [29, 33, 34]. There was no direct evidence for such an association in this study in the Deyang region. But indirectly, on average, male newborns were longer than female newborns, and their birth length was positively related to a higher risk for CS.

This study found that more CS mothers were overweight/obese (pre-pregnancy BMI ≥25 kg/m^2) than VD mothers. Although the difference was not significant, the situation was consistent with the theory that maternal overweight/obesity increases the risk of obstetric complications and ultimately leads to CS [29, 33].

Still coherent with other research findings [35-38], a mother's gestational weight gain was positively associated with CS. Further analysis found that if a pregnant woman gained ≥ 15kg,

her probability of undergoing a CS increased considerably. Based on experience, 15kg was roughly used as a cutoff point for excessive weight gain of pregnant women (ignoring the pre-pregnancy BMI) in the obstetric wards of the study area [38]. This finding provides a theoretical basis for the prevention of CS in local obstetrics. However, the guidelines for weight gain during the reproductive period are not yet well-established in China and different guidelines have been adopted by Chinese researchers [13, 14, 36, 39]. As suggested by the Institute of Medicine (IOM) [40], there are different suitable ranges for gestational weight gain based on the pre-pregnancy BMI classification (see Table 4.3). A closer look reveals that the average weight gain of underweight, normal and overweight/obese urban mothers exceeded already the upper limit of the recommended range. However, as the prevalence of CS in this study does not show significant urban-rural differences, and the WHO's BMI classification criteria are controversial among Chinese populations, this indicates that the validity of IOM's gestational weight gain recommendations for Chinese mothers needs to be verified.

One birth cohort study in Southwestern China found that underweight mothers were more sensitive to excessive GWG than the normal and overweight/obese mothers regarding the risk of CS [14]. This finding was not supported by our data. However, as nearly a quarter of mothers were found to be underweight (pre-pregnancy) in the study area, these correlations deserve more research and explorations. Moreover, nulliparous women and older mothers tended to gain more weight during the gestation period than parous women. Factors such as pre-pregnancy height, BMI, age, urban-rural disparities, household income, and parity need to be taken into consideration, to further establish the model of appropriate weight gain during pregnancy in China. In future work, the risk factors identified in this study can be used as reference indicators for personalized nutrition guidance during pregnancy.

4.4.3 Reasons for CS explained by mothers on postnatal wards

Whether the medical indications mentioned by the mothers were identical with the grounds of the hospital staff for performing a CS was not within the scope of this study. Nevertheless, the disparities between the proportion of CS in China and in neighboring countries (e.g. Republic of Korea 32%, Viet Nam 28%, Nepal 9% etc. [41]) indicate that medical reasons alone cannot

explain the high CS prevalence in China. And several national studies have confirmed that the high CS rate in China is largely due to social/cultural factors and the mothers' perceptions.

Also, in this study, a number of mothers stated that they themselves asked for the CS. In other words, these CS were performed without any medical indications or complications, but just based on the mothers' requests. As noted by Toledo SF et al., a higher social status gave mothers the right to choose whether or not to request a CS [42]. The root causes of elective CS are multifaceted.

Fear of labor pain might explain why so many mothers chose CS. At the end of 2017, an official newspaper, the *People's Daily,* reported that the prevalence of pain management (i.e. analgesia through non-pharmacological, medical and pharmaceutical methods) during childbirth in China was only 10%. However, it was 85% in America and over 90% in some European countries [43]. Lack of awareness by family members, as well as insufficient knowledge among the medical staff, with respect to pain management during delivery, influence more women to request a CS under anesthesia.

Different from previous generations, when marriage was usually ordered by parents, with the aim of offspring multiplication, sexual satisfaction is more and more important to young Chinese couples. Dyspareunia (painful intercourse) was found to be positively associated with perineal damage and assisted vaginal delivery [10]. Some women fear that a vaginal delivery will damage the birth canal and, thereby, affect the quality of sexual intercourse, so they choose a CS rather than a VD.

Most of the Chinese people deeply believe that the date of birth will determine the fate of child's life, and a CS can help them to choose a lucky day for their newborn. In addition, some women thought that a CS was healthy and safe enough, and others believed that a CS was fashionable. In such circumstances, mothers easily chose a CS without careful thought. However, in the atmosphere of the universal two-child policy, there is a declining trend of CS for the first child at maternal request in some areas of China in order to reduce the risks involved for the 2nd childbirth [29].

4.5 Limitation

The medical reasons for Cesarean delivery could not be compared with the reasons mentioned by postpartum mothers because the study team did not get access to the hospital records of CS after delivery.

4.6 Conclusions

In addition to medical factors, there were many interrelated reasons, such as socio-demographics, anthropometrics, people's perceptions and social background, which together induced this high prevalence of CS. From the perspective of maternity medical services, the disparities are getting smaller. Due to the historical trajectory of social-economic development, the differences between urban and rural areas in education, childbearing age, height, and nutritional intake of mothers would still have a significant impact on the prevalence of CS. To prevent CS, education about the complications and disadvantages of CS among mothers with higher education, older childbearing age, and primipara birth needs to be strengthened.

Referring to the dimension of maternal nutrition, both the short-term (such as GWG) and long-term nutritional status (such as height) of the mother can affect the type of delivery. Guidance for gestational weight gain, based on the anthropometric characteristics of the Chinese population, needs to be clearly established. In addition to pre-pregnancy body mass index (BMI), it is recommended to expand the sample size to study the significance of height as an independent factor for designing the GWG guidelines for Chinese mothers.

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4.8 Competing interests

No potential conflict of interest relevant to this article was reported by the authors.

4.9 Informed consent

Informed consent was obtained from all individuals included in this study.

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Chapter 5

General conclusion

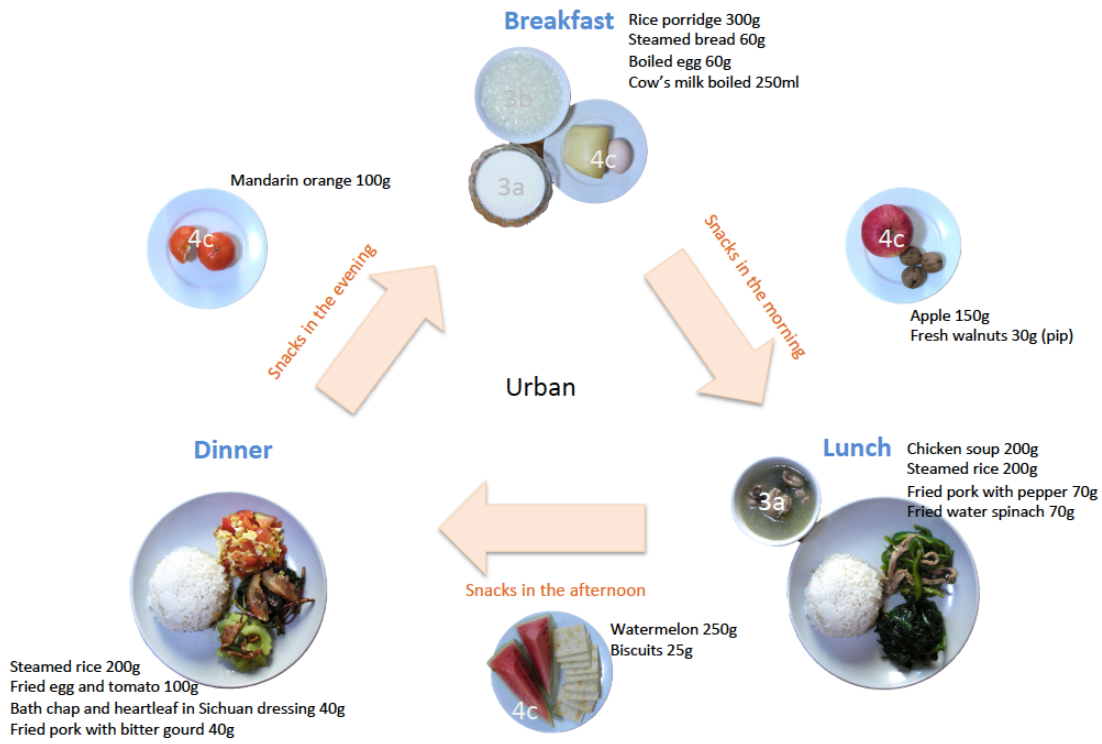
5 General conclusion

5.1 General discussion

5.1.1 Maternal nutrition in urban and rural areas of Deyang region, China

There were no significant differences in nutrient intake among pregnant women practicing any food taboos or increasing consumption of special foods, and the women who did not change their eating behavior during pregnancy. Meanwhile, the great dietary diversity in Chinese cuisine provides adequate alternatives to meet a balanced diet. Therefore, in this study, it appears that traditional dietary practices did not negatively affect maternal nutritional status. However, some food (i.e., beef, mutton or fish), which were avoided by many pregnant women, are widely considered to be healthy and nutritious food choices. More rural than urban women practiced food avoidance. An explanation for this could be that rural women were more influenced by traditional cultural values, while urban women had a higher educational level and more access to nutritional knowledge. Furthermore, the socio-moral pressures that pregnant women face from non- or partial adherence to food taboos should not be overlooked. As a consequence, in the event of a miscarriage or unhealthy fetus, women might be held accountable by their relatives. In order to avoid such situations, it is necessary to clarify that the principles behind taboos are mainly based on folklore rather than on scientific evidence.

Evaluation of the 24-h recalls indicated the need to improve the dietary intake of pregnant women living in Sichuan province. Findings of this study clearly show that there were distinct differences in energy as well as nutrient intakes among pregnant women residing in urban and rural areas of Deyang city (Table 2.3). In general, average energy consumption met the range of 20% allowance of RNI. Referring to the macronutrient composition of pregnant women's diets, the consumption of carbohydrates should be increased to meet the lower limit of the healthy range. Protein intake was deficient in the rural areas, whilst urbanites were still above 80% of RNI. The fat intake was excessive at both urban and rural survey sites, exceeding the upper healthy range.



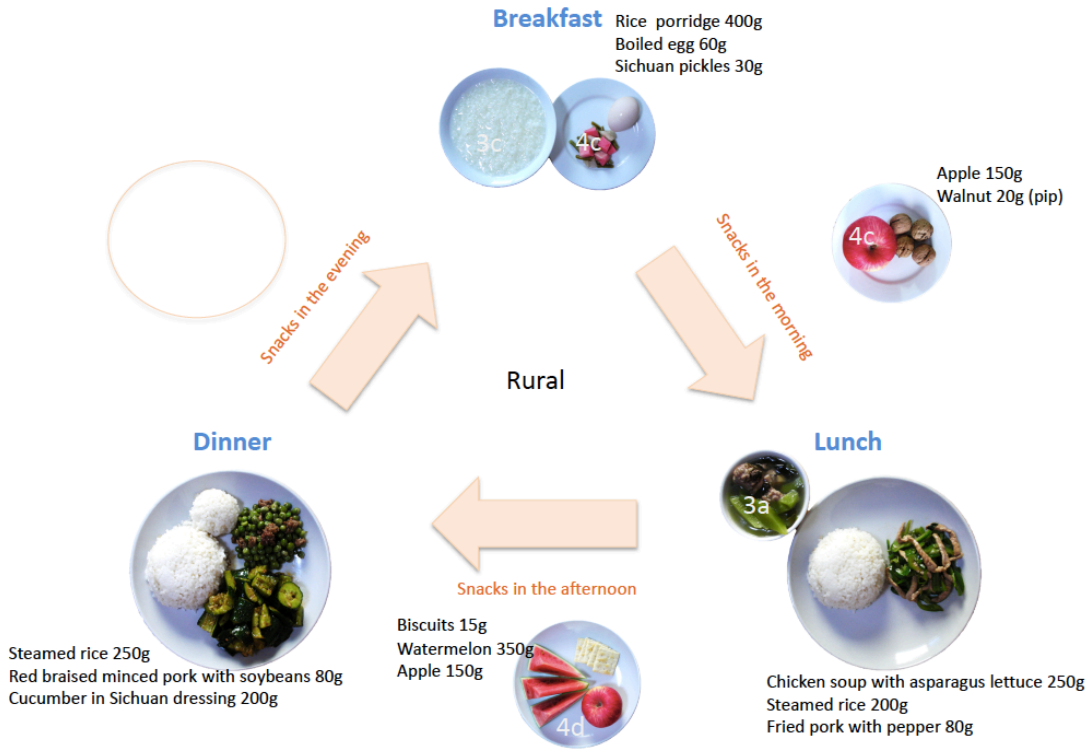


Figure 5. 1 Examples of daily food intakes of urban and rural pregnant woman

Of special concern is the excessive addition of cooking oil during food preparation, which results in passive overconsumption of fat. The dietary intake of most micronutrients was more or less deficient in both study sites, but low intake was more pronounced in rural than in urban areas. In summary, apart from fat intake, urban women had more nutritious and diversified diets than rural women in this study. Taking these factors together, it can be reasonably assumed that rural women are more vulnerable to nutritional imbalances than are urban women.

As indicated in Table 2.4, urban women consumed more animal-based foods compared to rural women. Inferentially, rural women could increase animal foods to improve their dietary quality. Normally, both rural and urban women bought food from local traditional markets. Food diversity is much higher in urban than in rural markets and the markets are much closer to home for urban families than for rural ones. High price and low availability in rural markets could be the reason that rural women consumed less cow's milk and seafood than urban women (Table 2.4). Low food diversity in rural markets could also be responsible for lower vegetable consumption by rural women. Furthermore, rural women tended to eat home-grown vegetables of which there were limited varieties available, which is assumed to contribute to the insufficient representation of vegetables in rural women's diets.

5.1.2 Disparities between urban and rural areas

According to the results of this study, some of the disparities in social, demographic and anthropometric status between urban and rural mothers still existed in the study area. On average, urban mothers had significantly higher incomes, were better educated and were about two years older when they conceived than were rural mothers (see Table 3.1). One study in rural western China indicated that the age of the woman was positively correlated with anemia and that the higher the wealth index of the household, the lower the prevalence of maternal anemia [1].

Referring in this study to the mothers' anthropometric status before pregnancy, urban mothers were two centimeters taller than rural mothers. Potentially, this may have influenced birth outcomes, the type of delivery, as well as the type of infant feeding. Most of the mothers in both areas had a pre-pregnancy BMI within the normal range. This study found that the proportion of

underweight mothers was high in both urban and rural areas (21.9% urban vs. 22.6% rural), while the prevalence of overweight/obesity was relatively low in both areas (2.1% urban vs. 6.5% rural).

With respect to birth outcomes, urban newborns were significantly taller and heavier than rural infants in the study area, which could be explained by the fact that the urban mothers were taller and gained more weight during pregnancy than rural mothers. Although the problems of low birthweight and high birthweight infants were not serious in the study area, since pre-pregnancy underweight is known to be associated with poor birth outcomes (i.e., premature birth, low birthweight) [2], more attention needs to be paid to urban and rural underweight women in reproductive age, especially for rural underweight pregnant women as recommended by Gao et al. [3].

5.1.3 Breastfeeding in urban and rural areas

This study found that, soon after childbirth (3-5 days), nearly all mothers had started breastfeeding. However, with reference to exclusive breastfeeding before discharge from hospital, the prevalence of EBF was extremely low in both urban (8.1%) and rural areas (5.2%). Although in this study, no significant difference in infant feeding in urban and rural areas was found on postnatal wards, the situation was inadequate in both settings.

In this study, only 6.6% of the mothers initiated breastfeeding within one hour after delivery as recommended by WHO. This is in line with the fact that local people in Sichuan region lack the knowledge that "breastfeeding should be started within the first hour after birth" [4]. "Lack of knowledge about early initiation of breastfeeding" and "Caesarean section" were given as the main reasons for delaying the initiation of breastfeeding. Both quantitative and qualitative results reflected that: (a) there is a need to improve the implementation of the "Ten Steps to Successful Breastfeeding", both in urban hospitals and rural clinics in the study area and (b) it can be explained by a misunderstanding of what "initiate breastfeeding" means in the local area. In the study area, "initiate breastfeeding" does not have the same meaning as "start sucking". The mothers insisted they would not start breastfeeding until they felt that they had breast milk or that their breasts were engorged, even if the baby had started sucking (breastfeeding) several hours or

even a few days earlier. This misunderstanding may partly explain why the study results for EBF were so dramatically low.

Due to the widespread delay in breastfeeding, offering of pre-lacteal feeding and the use of infant formula as a supplement to breast milk, the prevalence of EBF was only 8% on postnatal wards. Ignoring the misunderstandings regarding breastfeeding initiation and the influence of pre-lacteal feedings, the prevalence of EBF/AEBF could be up to 42.5% in this study.

When the newborns' lengths were shorter than 50 cm, their chances of being breastfed (almost) exclusively were lower compared to those who were ≥50 cm. This result was consistent with the actual situation. Smaller newborns might face more difficulties than ordinary newborns in terms of feeding management, nipple engagement, and sucking strength. This is why nurses and midwives should offer more breastfeeding support to the mothers with smaller sized newborns/infants.

Caesarean section (CS) was related to the time of initiating breastfeeding in this study. Many other studies noted that CS delays the initiation of breastfeeding [5, 6] and is associated with the use of supplements among newborns [7] and mothers who had CS experienced more breastfeeding problems [8, 9]. The proportion of CS was over 60% in this study area, CS could, accordingly, be defined as one of the risk factors for not exclusively breastfeeding. Thus, further work/research to reduce CS in China would be important for promotion of breastfeeding.

Unexpectedly, both the mothers' educational levels and their knowledge of colostrum were negatively correlated with their feeding practices. In focus group discussions, the mothers' knowledge of the definition of exclusive breastfeeding was found to be poor. Several mothers had no idea what exclusive breastfeeding meant (Table 3.7) or had mentioned a too long or too short duration of exclusive breastfeeding. Both of the quantitative and qualitative data indicated that wrong information or misunderstandings about breastfeeding were widespread in the study area. For example, "besides breast milk, water is necessary", "water is essential as the first drink for newborns", "exclusive breastfeeding is good, but difficult to practice", "there was no/too little breast milk available immediately after childbirth" and so on. These were common perceptions

by mothers, grandparents, peers, and even some of the medical staff. Due to these misunderstandings, many expectant mothers had purchased one box of infant formula, feeding bottles and brought them already to the hospital before childbirth. It could also explain why more than 80% of the infants got infant formula as a pre-lacteal feed before the onset of lactation. This misunderstanding was also related to the delay in the initiation of breastfeeding, as the mothers believed that there was no milk in the breasts after birth and, therefore, they needed to wait until they breasts were engorged or when they felt they had started to have breast milk. These misunderstandings need to be corrected during local breastfeeding promotion sessions.

Obviously, the feeling/perception that "the amount of breast milk produced was not enough" was one of the major reasons mentioned by mothers in study areas. In other studies, "insufficient breast milk syndrome" has also been considered an important barrier to successful breastfeeding [10-12]. Because mothers usually cannot measure the amount of breast milk a baby has drunk, the mothers in our study often lacked confidence about whether their babies were satisfied or wondered if they were still hungry. In order to match the growth charts at the monthly childcare examination, these mothers preferred giving additional infant formula to their babies after breastfeeding. During the course of this study, it became obvious that the physiology of breast milk production was not clearly understood. Thus, education on the physiology of breast milk production and secretion and the related importance of frequent suckling should be included in the maternal school curriculum.

Due to the widespread inappropriate advertising for infant formula in China, parents believed that many health benefits are linked to formula feeding. Perceptions, such as infant formulas being as nutritious or even superior to breast milk, influenced several mothers to offer these formulas as supplements in addition to breastfeeding. To reduce the impact of the unsubstantiated health claims of the infant formula companies [13] the Ministry of Health of China already issued a ban on aggressive advertising of infant formula in 1995 [14]. However, due to lack of control mechanisms, the ban has not been effective.

5.1.4 Factors associated with Caesarean Section

Although most mothers reflected that natural childbirth was more beneficial than CS and they thought most mothers might choose VD, however, there was a big gap between the mothers' views and their actual practice, as nearly two-thirds of the mothers in this study delivered by CS. There are complex interrelated factors affecting the high prevalence of CS.

The strong popularity of institutional delivery in China has enabled mothers in both urban and rural areas to access medical services. Great improvements in maternal health services across the country [15] and the expansion of maternity insurance coverage [16, 17] make the cost of childbearing in a hospital affordable. This can explain why the mothers' region of residence (urban vs. rural) and their household per capita income were not found to be associated with the occurrence of CS in this study.

The average level of education for mothers undergoing a CS was significantly higher than that of mothers who had vaginal delivery (VD). Better education often means higher levels of economic independence and self-awareness, which allows mothers to have more freedom of choice. Better education also means a better understanding of the risks of CS and the benefits of a natural delivery. But more highly educated mothers have frequently opted for a CS, which goes against people's understanding of their high cognitive abilities. This showed that there were other factors beyond the rational cognition of mothers when they decide whether to choose CS.

The average age of mothers who underwent a CS was higher than that of mothers who had a VD. If the mother's age was ≥ 28 years, the likelihood of having a CS doubled compared to those who were younger than 28 years. The risk of dystocia usually increases with the age of the mother [18], and this trend is more pronounced in nulliparous women than in parous women [19]. It is of practical significance to use the age of 28, the 75% percentile of childbearing age of local women, as a reminder of CS for nulliparous women.

Mothers undergoing a CS tended to be shorter on average than that of VD mothers ($p=0.067$.) When using the median "158 cm height" as the cutoff, a mother, who was <158 cm, was about

twice as likely to experience a Cesarean section as compared to a mother who was taller than 158 cm. There is a correlation between a mother's height and whether she has had a CS [20-22]. Mothers of short stature have a higher risk of cephalopelvic disproportion[21], and the risk of cephalopelvic disproportion may be exacerbated by differences in growth environment and nutrition between the two generations of mothers and children [20]. Body height is an indicator of long-term nutritional status. It can be inferred that, due to the improvement of the living environment and nutritional intake in the later stage of pregnancy, mothers of short stature, especially those who consumed higher amounts of food than recommended during pregnancy, will have a higher risk of CS. It follows that, in addition to BMI, body height should be used as an independent reference factor for guiding gestational weight gain and nutritional intake of pregnant women.

Further analysis found that if a woman had gained more than 15kg during pregnancy, her probability of undergoing a CS increased considerably. Based on experience, 15kg was roughly used as a cutoff point for excessive weight gain of pregnant women (ignoring the pre-pregnancy BMI) in the obstetric wards of the study area [23]. This finding provides a theoretical basis for the prevention of CSs in local obstetrics. However, the guidelines for weight gain during the reproductive period are not yet well-established in China and different guidelines have been adopted by Chinese researchers [24, 25]. As suggested by the Institute of Medicine (IOM) [26], there are different suitable ranges for gestational weight gain based on the pre-pregnancy BMI classification (underweight, normal, overweight/obese， see Table 4.3). A closer look will reveal that the average weight gain of underweight, normal and overweight/obese urban mothers exceeded the upper limit of the recommended range. Excessive weight gain could also induce more adverse perinatal outcomes (i.e. CS) compared to those of the mothers with a gestational weight gain in the normal range. However, as the prevalence of CSs in this study does not show significant urban-rural differences, and the WHO's BMI classification criteria are controversial among Chinese populations, this indicates that the validity of the IOM's gestational weight gain recommendations for Chinese mothers needs to be verified. Linear regression revealed that other factors, such as maternal pre-pregnancy height, the mother's age and household per capita income, were positively correlated with gestational weight gain. Nulliparous women tended to gain more

weight during the gestation period than parous women. In general, factors such as pre-pregnancy height, BMI, age, urban-rural disparities, household income, and parity need to be taken into consideration, to further establish the model of appropriate weight gain during pregnancy in China. In the study area, doctors usually provide simple advice (i.e. eat more/less) for weight control, but no professional dietitian gives personalized advice based on the individual condition of a pregnant woman in accordance with their different needs over the course of the three trimesters. In future work, the risk factors identified in this study can be used as reference indicators for personalized nutrition guidance during pregnancy.

Nevertheless, the disparities between the proportion of CS in China and in neighboring countries indicate that medical reasons alone cannot explain the high CS prevalence in China. Meanwhile, several national studies have confirmed that the high CS rate in China is largely due to social/cultural factors and the mothers' perceptions. In this study, a number of mothers stated that they themselves asked for the CS. In other words, many of these CSs were performed without any medical indications or complications, but just based on the mothers' requests. As noted by Toledo SF et al., a higher social status gave mothers the right to choose whether or not to request a CS [27]. The root causes of elective CS are multifaceted. Fear of labor pain might explain why so many mothers chose CSs. At the end of 2017, an official Chinese newspaper, the *People's Daily,* reported that the prevalence of pain management (i.e. analgesia through non-pharmacological, medical and pharmaceutical methods) during childbirth in China was only 10%. By contrast, it was 85% in America and over 90% in some European countries [28]. Furthermore, most of the Chinese people deeply believe that the date of birth will determine the fate of a child's life, and a CS can help them to choose a lucky day for their newborn. In addition, some women thought that a CS was healthy and safe enough, and others believed that a CS was fashionable. In such circumstances, mothers easily chose a CS without careful thought about the side effects. However, in the atmosphere of the more recently established universal two-child policy, there is a declining trend of CSs for the first child at maternal request in some areas of China in order to reduce the associated risks involved for the 2nd childbirth [29].

5.1.5 Lifestyle of modern mothers

The shifting attitude about breasts among modern women was another barrier to exclusive breastfeeding in China. Historically, the main function of breasts was simply feeding an infant/young child. People perceived "small and exquisite breasts" as beautiful [30]. According to traditional Chinese culture, small feet but not breasts were the important sexual organs [30, 31]. However, in contemporary China, the role of breasts as a sexual stimulant is surpassing its feeding function, just as in other industrialized countries [32, 33]. More and more mothers and their husbands choose infant formulas instead of breastfeeding, because they believe breastfeeding could cause mothers' breasts to shrivel or sag. To solve this increasing problem, mothers need a better understanding of the physical structure and the function of breasts through improved breastfeeding education. The mainstream media should take responsibility for highlighting maternal aspects of breastfeeding rather than focusing only on the erogenous function of breasts.

Different from previous generations, when marriage was usually ordered by parents, with the aim of offspring multiplication, sexual satisfaction is more and more important to young Chinese couples. Dyspareunia (painful intercourse) was found to be positively associated with perineal damage and assisted vaginal delivery [34]. Some women fear that a vaginal delivery may damage the birth canal and, thereby, affect the quality of sexual intercourse, so they choose a CS rather than a VD.

5.1.6 Concerns about food safety and sustainable nutrition

As a result of this study, the majority of the women improved their concerns about nutrition and food safety since the onset of pregnancy. Their methods of ensuring food safety were avoiding food additives or pesticides, eating food from farmer's market or grown by their own farm products, reducing raw food and less eating out etc. During the time period of this survey, a few pregnant women or postpartum mothers mentioned consuming organic food. Almost no one was aware of the concept of sustainable development, sustainable agriculture or sustainable nutrition. In the process of choosing food and feeding mode, mothers hardly considered factors, such as the consumption of natural resources and environmental contaminations. Neither the low prevalence

of exclusive breastfeeding nor the high rate of Caesarean section was in line with the concept of sustainable development. People's awareness of sustainable development needs to be continuously improved along with economic development in China.

5.2 Conclusion

From pregnancy to the early stages of the newborn's life, there are still many nutrition-related factors and social perceptions that may adversely affect the health of mothers and babies in the study area.

Before conception, about a quarter woman were found to be underweight with a BMI of <18.5, while underweight among women was more pronounced in rural areas as compared to urban areas. On average urban mothers were 2 centimeters taller than rural mothers. If 155cm is defined as the cutoff point, the prevalence of short stature among local mothers could be up to 25%. Overweight/obesity among women was not a common problem in the study area, but overweight/obese women were more likely to consume too much food during pregnancy (according to IOM's recommendation). Pre-pregnancy BMI, and short stature are clear factors associated with gestational weight gain, birth outcome and risk of Caesarean section. But these factors have not yet become controlling indicators of antenatal care in the study area.

During pregnancy, the energy consumption was, on average, close to RNI fulfilment. The contribution of fat to total energy was higher than the upper limit of AMDRs (30%). The average intake of thiamin, riboflavin, Ca, Mg, Fe, and Zn was below 80% of RNI. Urban pregnant women had more desirable intakes in all nutrients (except for fat) than rural women but still had low intakes of certain micronutrients. Thanks to the highly diversified diet in the local area, the traditional food taboos during pregnancy may have limited negative effects on the nutritional intake of women. Roughly speaking, the average gestational weight gain of local pregnant women was 15kg, which seems to be within a reasonable range. But if we look into the urban and rural differences, urban women tended to gain more weight than the upper limits of the recommendation, while rural women were more rational than urban women on the point of gestational weight gain. However, at the same time, more rural women were underweight before

pregnancy than was the case with urban women. Therefore, in terms of weight gain and nutrition guidance during antenatal care, urban-rural differences should be fully considered.

Most infants (89.1% urban vs. 98.0% rural) were born at term (37-42 weeks, gestational age) in this study, but with respect to birth outcomes, there were urban-rural disparities. On average, urban newborns were heavier and taller than rural newborns. The prevalence of low birth weight (<2.5 kg) was nearly the same in urban and rural areas, whereas high birth weight (≥4 kg) was more common in urban than rural areas (see Table 3.2). These differences in birth outcomes reflected and verified the results of the long-term nutritional status of pregnant women in urban and rural areas.

Nearly all mothers started with a type of breastfeeding after birth. Only 8.1% of urban mothers and 5.2% of rural mothers could meet the requirement for "early initiation of breastfeeding within the first hour of life". Most of the mothers started breastfeeding on ≥ 2nd day post-partum. Before the initiation of breastfeeding, 87.3% of the newborns were fed with pre-lacteal food mainly in the form of infant formula. Although disparities in infant feeding between urban and rural areas exist, the situation is inadequate in both settings. The extremely low prevalence of exclusive breastfeeding among newborns was found to be associated with delayed initiation of breastfeeding and widespread use of infant formula in addition to breastfeeding. Directly and indirectly, the high prevalence (67%) of Caesarean section, the mothers' poor knowledge of the physiology of breast milk production, the misleading information in the aggressive advertising of infant formula as well as the shifting perception of the primary function of the breasts by modern people have led to an unfavorable breastfeeding status in the study area.

There was a very high prevalence of CSs in the Deyang study area. In addition to medical factors, there were many interrelated reasons, such as socio-demographics, anthropometrics, people's perceptions and social background, which together influenced this high prevalence of CS. From the perspective of maternity medical services, the disparities are getting smaller. Due to the historical trajectory of social-economic development, the differences between urban and rural areas in education, childbearing age, height, and nutritional intake of mothers would still have a significant impact on the prevalence of CS. To prevent CS, education about the complications and

disadvantages of CSs among mothers with higher education, older childbearing age, and primipara birth needs to be strengthened. Referring to the dimension of maternal nutrition, guidance for gestational weight gain, based on the anthropometric characteristics of the Chinese population, needs to be clearly established. At the same time, professional nutritionists are needed to provide personalized nutritional guidance for expectant mothers with comprehensive consideration of all aspects, such as place of origin, maternal height, gestational weight gain etc. In addition to perceived medical indications for CSs, maternal requests for a CS need to be tackled, especially in urban areas.

Figure 5. 2 Example of recommended daily food intake for pregnant women in the Deyang area

To sum up, both the mothers' pre-pregnancy nutritional status and inadequate diet during pregnancy in the study area had an impact on birth outcomes and feeding practices. At the same

time, the lack of knowledge about breastfeeding and the general misunderstanding of breastfeeding due to social and cultural factors hindered the promotion of breastfeeding in the study area.

Picture 5. 1 Sharing research results with the Pediatric Branch of the Deyang Medical Society

5.3 Limitations

Despite the random selection of medical institutions, the results cannot be generalized for the total population of pregnant women in the study area. However, between 2006 and 2010 the majority of Chinese women (96%) delivered in medical institutions. Based on this additional information it can be assumed that pregnant women recruited from the hospitals constitute a good representation of the population of pregnant women in the study area.

It is likely that women who delivered their babies naturally, without any complications, were discharged earlier and, consequently, were not included in our postnatal assessment, which took place during the first week after delivery. Therefore, women who delivered their newborns by

Caesarean section may be overrepresented by comparison to those who delivered without any complications and left the hospital earlier. In addition, the traditionally dominant role of family members (i.e. father, grandmother) with regard to infant feeding and CSs recommendations was not adequately considered in this study. It could have been useful in explaining the unfavorable breastfeeding situation in the study area.

Due to serious sample loss (such as changing phone numbers, going out to work and so on), the results of the follow-up study were insufficient, so no further analysis was performed.

From a nutrition-related perspective, immediately after childbirth, the recovery of the postnatal mother and initiation of breastfeeding were the two major tasks in a family. After delivery, the diet of mothers often followed strict traditional customs and shifting from soft/liquid foods into nutritious foods which promote breast milk production (simultaneously, the cold and hot properties of foods should be followed according to traditional Chinese medicine). However, due to complicated traditional concepts and differences in maternal conditions, the diet of postnatal mothers varied daily, and it was very difficult to quantify the dietary characteristics of them. This study did not analyze the maternal dietary intake.

5.4 Recommendations

Pregnant women need more specific nutritional guidance in the study area and, at the same time, their differences in social background, such as urban and rural location, age, education etc., must be fully considered. Roughly speaking, local pregnant women could be advised to reduce cooking oil consumption and increase nutrient-dense foods and food diversity.

On the other hand, the control of gestational weight gain, i.e. personalized advice based on the individual condition of pregnant women (pre-pregnancy BMI, body height), in accordance with their different needs and food habits, could play a role in preventing CSs in the study area. More localization research is needed to develop recommendations for gestational weight gain in China. After the second child policy was released, people's perception and practice of CSs need to be investigated. Mothers need to be clearly informed about the complications and disadvantages of

CS, especially for those who have a high educational level and/or are age ≥ 28 years at the time of childbirth.

At the hospital level, the implementation of the "Ten Steps to Successful Breastfeeding" needs to be strengthened in both urban and rural areas. More professional support needs to be provided at the initiation of breastfeeding, in order to overcome the misconceptions that there is no breast milk or insufficient milk after delivery and help new mothers quickly acquire feeding skills. Nationally, effective systems for monitoring the ban on inappropriate advertising of infant formula are necessary. The mainstream media should also take responsibility to promote breastfeeding.

5.5 References

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2013-2015	**University of Hohenheim, Institute of Gender and Nutrition (430b)** Scientific staff Assistance in Master' module "Global nutrition", lecturer, literature researching, research assistant, co-supervision of Master's thesis. Stuttgart, Germany.
02/2014 & 02/2008	**Chengdu Apiculture Feng Co., Ltd.** Translation work and tour guide during *Biofach 2008.* Nürnberg, Germany.
02/2013	**Organic and Beyong Co., Ltd.** Organization of visits to organic farms, organic supermarkets and markets, visits to the Hohenheim Agricultural Museum, and exchange meetings with experts in Hohenheim. Stuttgart, Germany.
03/2005	**Yunxin Co., Ltd.** Internship, subject: Technology of alcohol production in workshop. Yunna, China
06/2004	**Dali Beer Factory** Internship, subject: Technology of beer production and its major procedures. Yunnan, China

Publications

1. Gao H, Wang Q, Hormann E, Stuetz W, Stiller C, Biesalski HK et al. *Breastfeeding practices on postnatal wards in urban and rural areas of the Deyang region, Sichuan province of China*. Int Breastfeed J. 2016;11:11. doi:10.1186/s13006-016-0070-0.

2. Gao, H., Stiller, C., Wang, Q., Hormann, E., & Scherbaum, V. (2014). *Birth outcomes and infant feeding practices in urban and rural areas of the Deyang region, Sichuan Province, China*. Paper presented at the 5th International Conference on Nutrition and Nurture in Infancy and Childhood—Relational, Bio-cultural and Spatial Perspectives, Sydney

3. Gao H, Stiller CK, Scherbaum V, Biesalski HK, Wang Q, Hormann E et al. *Dietary intake and food habits of pregnant women residing in urban and rural areas of Deyang city, Sichuan province, China*. nutrients. 2013;5:2933-54.

4. Gao, H., Stiller, C. K., Scherbaum, V., Wang, Q., Biesalski, H. K., Hormann, E., & Bellows, A. C. (2013). *Dietary patterns of pregnant women in urban and rural areas of deyang region, sichuan province of china*. Paper presented at the APCCN 2013, Tokyo, Japan.

5. Gao H, Scherbaum V, Hormann E, Wang Q. *Breastfeeding after Earthquakes*. Birth. 2010;37(3):264-5.

Other Research Experience

2020	Research design "The impact of social isolation on the neuropsychological development of infants and young children during the Coronavirus (COVID-19) pandemic". Deyang, China.
2015-2018	Research design and communication work in the project "Anemia status of young children in relationship to maternal nutritional status and feeding practices" Deyang, China.
06/2012	Training medical staffs in Maternity and Child Health Care Hospital of Deyang city to do dietary survey. Deyang, China.
02/2012 & 08/2012	Organization of annual conference of pediatrics in Deyang city, introduction of German research group from Institute of Gender and Food at University of Hohenheim into medical society of Deyang region. Presentation of research results in the conference. Planning and completion of Germen experts' visiting in China.
2007	**Jauernik Farm** (Organic sheep farm) Student research project: Effects of increasing concentrate on sheep milk. Stuttgart, Germany.
2005-2006	**Chengdu Baishida Medical Technology Development Co., Ltd.** Research assistant: Experimental work and paper writing concerning development and research of new drugs (3 months). Chengdu, China.
2004	**Kunming University of Technology** Student research project: Control temperature falling of syrup in sucrose crystallization. Kunming, China.

Research Grant & Fellowship

11/2010- 6/2012	Sino-German exchange grant from Robert-Bosch Stiftung
2010	Research grant from Fiat Panis-Stiftung Ulm
06/2009-05/2011	PhD scholarship from Faculty of Agricultural Science at University of Hohenheim
2008	Eiselen thesis research grant

Skills & Qualifications

Software	Nutrisurvey, ICF, ADOS-2, SPSS, Nvivo, Endnote, Word, Excel, PPT etc.
Languages:	English, Mandarin

Deyang, China 12.09.2020
Place, Date

Haoyue Gao

Haoyue Gao

Declaration in lieu of an oath on independent work

according to Sec. 18(3) sentence 5 of the University of Hohenheim's Doctoral Regulations for the Faculties of Agricultural Sciences, Natural Sciences, and Business, Economics and Social Sciences

1. The dissertation submitted on the topic

Food and Nutritional Aspects during Pregnancy and Infancy in Southwestern China

is work done independently by me.

2. I only used the sources and aids listed and did not make use of any impermissible assistance from third parties. In particular, I marked all content taken word-for-word or paraphrased from other works.

3. I did not use the assistance of a commercial doctoral placement or advising agency.

4. I am aware of the importance of the declaration in lieu of oath and the criminal consequences of false or incomplete declarations in lieu of oath.

I confirm that the declaration above is correct. I declare in lieu of oath that I have declared only the truth to the best of my knowledge and have not omitted anything.

Deyang, China 12.09.2020

Place, Date

Signature