سی سال تلاش

برای کنترل اختلال های ناشی از کمبود ید
در جمهوری اسلامی ایران

دکتر حسین دلشاد

دکتر فریدون عزیزی

کمبود ید

مهمترین عامل کاهش ضریب هوشی انسانها

روش های شناسایی

و پیش گیری

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تقدیر و تشکر:

همکاری مستمر سیاستگزاران، برنامه ریزان و مجریان برنامه های سلامت موجبات حذف کمبود ید در کشور را فراهم نمود. به جا است که از همه عزیزانی که در این جهاد علمی- اجرایی برای ارتقا سلا مت جامعه کوشیده اند، از بهورزان کوشای روستاها تا عالی ترین سطوح تصمیم گیری و اجرایی در وزارت بهداشت ، درمان و آموزش پزشکی و دانشگاه های علوم پزشکی وابسته، وزارت صنایع و جهاد کشاورزی، کارکنان و کارشناسان مسئول بهداشت محیط ، ادارات نظارت بر مواد غذایی و آزمایشگاه و کنترل غذا و دارو ، ادارات آموزش و پرورش و مدارس استان های کشور و کلیه وزارتخانه های در گیر در طول ۳۰ سال اخیر سپاسگزاری نموده و برای همگی توفیقات الهی مسئلت نمائیم.

دکتر فریدون عزیزی - دکتر حسین دلشاد

فهرست مطالب

عنوان	صفحه
پیشگفتار	۹
مقدمه	۱۰
گواتر آندمیک	۱۱
کرتینیسم آندمیک	۱۲
ارزیابی کمبود ید در جامعه	۱۴
اندازه گیری غلظت ید ادرار	۱۴
ارزیابی شیوع گواتر	۱۵
اندازه گیری تیروتروپین سرم	۱۶
اندازه گیری تیرو گلوبولین سرم	۱۷

روش های پیشگیری از اختلال های ناشی از کمبود ید ۱۸

ید دار کردن نمک طعام ۱۸

محلول روغنی ید دار ۱۹

مهار اختلال های ناشی از کمبود ید در ایران ۲۱

وضعیت بیماری در ایران ۲۲

ساختار اجرایی برنامه کشوری پیشگیری و کنترل اختلال های ناشی از کمبود ید ۳۴

تصاویر برخی از افراد که در پایش های ملی و منطقه ای تغذیه ید جامعه فعالیت داشته اند ۵۲

اسامی برخی از افراد که در پایش های ملی و منطقه ای تغذیه ید جامعه فعالیت داشته اند ۵۷

فهرست مقالات منتشره در ارتباط با کمبود ید در ایران طی سی سال گذشته ۵۹

پیشگفتار

ید یکی از ریز مغذی های اساسی است که با شرکت در تولید هورمون های تیروئید در متابولیسم سلول ها و به ویژه پدیده رشد و توسعه در جنین و کودکان موثر است. کمبود ید سبب بروز اختلالهای وسیعی می شود که مهمترین آنها اثر مخرب بر توانایی های ذهنی و جسمی افراد جامعه و بخصوص کودکان و نو جوانان است. بدون شک کمبود ید مهمترین عامل عقب افتادگی رشد ذهنی بشر است که قابل پیشگیری می باشد. شایع ترین تجلی بالینی کمبود این ریز مغذی به صورت گواتر بوده که در کمبود شدید با اختلال عملکرد غده تیروئید نیز توام است اما بسیاری از اثرات کمبود ید در کاهش فعالیت مغزی است که ممکن است ظاهرا نمایان نباشد. با وجود ید دار نمودن نمک و مصرف همگانی نمک ید دار در اکثر کشور های دنیا پیشرفت های قابل توجه ای در طی چند دهه اخیر صورت گرفته است.

با شناخت جدی کمبود ید در سال ۱۳۶۸ در ایران و تلاش های ارزنده و مستمر ؛ همکاری و همدلی جمع عظیمی از فرهیختگان و پژوهشگران کشور ؛ عزم و اراده ملی ادارات ذیربط در وزارت بهداشت درمان و آموزش پزشکی و وزارت صنایع و جهاد کشاورزی؛ همت والای کارکنان و کارشناسان مسئول تغذیه؛ بهداشت محیط و اداره نظارت بر مواد غذایی و آزمایشگاه کنترل غذا و داروی استان ها؛ مشارکت مستمر دانشگاه های علوم پزشکی و ادارات آموزش و پرورش و مدارس در سطح کشور و در یک کلام تجلی زیبای عزم ملی و همکاری های درون و برون بخشی؛ حذف اختلال های ناشی از کمبود ید در مدت کمتر از یک دهه در کشور صور ت گرفت و جمهوری اسلامی ایران به عنوان اولین کشور عاری از کمبود ید در منطقه در سال ۲۰۰۰ میلادی شناخته شد .

امید است با توفیقات الهی و همکاری مستمر سیاستگزاران؛ برنامه ریزان و مجریان برنامه های سلامت موجبات استمرار حذف کمبود ید در کشور فراهم گردد. این کتاب بعنوان سپاسگزاری به همه عزیزانی که در این جهاد علمی-اجرایی برای ارتقا سلامت جامعه در سی سال گذشته کوشیده اند تقدیم می شود.

دکتر فریدون عزیزی – دکتر حسین دلشاد

مقـــــدمه

ید یک عنصر شیمیایی از گروه هالوژنها بوده که بصورت مولکولی حاوی دو اتم ید (I_2) و به شکل یون آیوداید (Iodide) در طبیعت موجود است. منشا اصلی ید جلبکها و فیتو پلانکتونهای دریایی هستند. این موجودات گازهای ارگانیک ید دار بنام متیل آیوداید (Methyl Iodide) از خود آزاد نموده که پس از ورود بداخل آب دریاها و اقیانوسها سر انجام از سطح آب تبخیر و وارد اتمسفر می شوند. سالانه حدود ۴۰۰۰۰۰ تن ید از این طریق به اتمسفر اضافه می گردد. متیل آیوداید (CH_3I, CH_2I_2) در اتمسفر تحت اثر تابش نور خورشید به ید غیر آلی تبدیل گردیده و بصورت قطرات ریزی(ائروسل) در جو زمین پراکنده می شود. ریزش باران و یا رسوب مستقیم این قطرات ید را مجددا به زمین و آب دریاها و اقیانوس ها بر می گرداند. در مقایسه با یدی که کره زمین از راه تبخیر از دست می دهد ید کمتری از اتمسفر به زمین بر می گردد. لذا با توجه به اینکه هیچ منبع طبیعی دیگری برای جایگزینی آن وجود ندارد کمبود ید در خاک پایدار خواهد بود. ید در پوسته زمین ذخیره شده و از نظر فراوانی شصت و یکمین عنصر شیمیایی موجود در آن محسوب می گردد. ریزش باران و جاری شدن سیلاب باعث شستشوی پوسته زمین و سرازیر شدن آن از مناطق مرتفع به سمت مناطق کم ارتفاع و نهایتا به داخل آب دریاها و اقیانوس ها می گردد. نتیجه این چرخه کاهش ید مناطق مرتفع و کوهستانی زمین خواهد بود و تمام گیاهانی که در چنین خاکی رشد می کنند کمبود ید خواهند داشت. انسانها و حیوانات نیز که بطور کلی از منابع غذایی رشد نموده در این خاک ها تغذیه می شوند با کمبود ید روبرو خواهند بود . میزان ید موجود در گیاهان رشد نموده در خاک های با کمبود ید ۱۰ میکروگرم به ازای هر کیلو گرم وزن خشک آنها بوده در حالیکه این مقدار برای گیاهان رشد نموده در خاک هایی که ید کافی دارند به ۱۰۰۰ میکروگرم به ازای هر کیلو گرم وزن خشک آنها می رسد.

ید یک عنصر اساسی برای تولید هورمونهای تیروئید و رشدونمو مغز انسان و حیوانات بوده و کمبود آن یک معضل قدیمی نوع بشر و یکی از شایع ترین علل قابل پیش گیری آسیب مغزی در دنیای امروزی تلقی میشود. اهمیت بیولوژیکی ید شرکت در ساختمان هورمون های تیروئید (T3 , T4) است. هورمونهای تیروئید در تنظیم متابولیسم بیشتر سلول های بدن و همچنین در رشد و نمو فیزیکی و تکامل سیستم عصبی انسان و حیوانات نقش حیاتی دارند. کمبود ید عملکرد تیـــروئیـد را دچار اختلال نموده و بر حسب اینکه این کمبود در چه زمانی حاصل شود و نیز بر اساس شدت کمبود آن عوارض و تغییرات حاصله را تحت عنوان اختلا لهای ناشی از کمـبود ید (Iodine Deficiency Disorders = IDD) تقسیم بنـــــدی می کنند (جدو ل ۱)

فهرست مقالات

در ارتباط با کمبود دید در ایران در طی سی سال گذشته

(۱۳۹۵-۱۳۶۴)

عزیزی

مجله دانشگاه علوم پزشکی ایلام، شماره ۴۷، تابستان ۱۳۸۴ ص ۴۸

۳۳- **بررسی علل کم کاری مادرزادی تیروئید گذرا در تهران و دماوند**

آرش اردوخانی ، مهدی هدایتی ، پروین میرمیران ، الهه عینی ، هوشنگ ثابت سعیدی ، فریدون عزیزی

مجله غدد درون ریز و متابولیسم ایران، شماره ۲۲، تابستان ۱۳۸۳ ص ۱۰۷

۳۴- **پیشگیری از کمبود ید در کشور برنامه ای مستمر و موفق ولی نا کافی**

دکتر فریدون عزیزی

فصلنامه پژوهش در پزشکی ، سال بیست و هشتم، شماره ۳، پائیز ۱۳۸۳ ص ۱۵۹

۳۵- **شیوع بالای هیپوتیروئیدی شدید نوزادان: نیاز برای استراتژی تشخیصی و درمانی موثر در برنمه کشوری غربالگری کم کاری مادرزادی تیروئید**

دکتر آرش اردوخانی ؛ پروین میرمیران ؛ دکتر مهدی هدایتی ؛ دکتر علی رمضانخانی ؛ دکتر فریدون عزیزی

فصلنامه پژوهش در پزشکی ، سال بیست و هشتم، شماره ۱، بهار ۱۳۸۳ ص ۴۳

۳۶- **غربالگری کم کاری مادرزادی تیروئید ، شروعی دیر هنگام ولی نویدبخش**

فریدون عزیزی

مجله غدد درون ریز و متابولیسم ایران، شماره ۲۱، بهار ۱۳۸۳ ص ۱

۳۷- **کم کاری مادرزادی تیروئید دایمی و گذرا در تهران و دماوند**

آرش اردوخانی ، پروین میرمران ، مارینا پور افکاری ، عیسی نشاندار اصل ، فریدون فتوحی ، مهدی هدایتی ، فریدون عزیزی

مجله غدد درون ریز و متابولیسم ایران، شماره ۲۱، بهار ۱۳۸۳ ص ۵

۳۸- **پایش شیوع گواتر و میزان ید ادرار در دانش آموزان ۸ تا ۱۰ ساله استان خوزستان در سال ۱۳۷۵**

فریدون عزیزی ، پروین میرمیران ، ربابه شیخ الاسلام ، مهدی هدایتی ، حسین دلشاد ، جمشید بهلکه

مجله علمی پزشکی جندی شاپور، شماره ۳۵، اسفند ۱۳۸۱ صص ۹-۱۵

۳۹- **اختلالات ناشی از کمبود ید در منطقه مدیترانه شرقی و خاورمیانه**

فریدون عزیزی

مجله غدد درون ریز و متابولیسم ایران، شماره ۱۵، پائیز ۱۳۸۱ ص ۱۴۹

۴۰- **اختلالات عملکرد تیروئید و آنتی بادی های تیروئید یک دهه پس از شروع جایگزینی با نمک یددار: مطالعه تیروئید تهران**

دکتر پیمانه حیدریان ، دکتر فریدون عزیزی

مجله غدد درون ریز و متابولیسم ایران، شماره ۱۶، زمستان ۱۳۸۱ ص ۲۲۹

۴۱- **پایش شیوع گواتر و میزان ید ادرار در دانش آموزان ۸ تا ۱۰ ساله استان خراسان در سال ۱۳۷۵**

فریدون عزیزی، ربابه شیخ الاسلام، مهدی هدایتی، پروین میرمیران، گیتی عباسی، حسین دلشاد

مجله دانشکده پزشکی دانشگاه علوم پزشکی مشهد، شماره ۷۵، بهار ۱۳۸۱ صص ۳۵-۴۰

۴۲- **ارزیابی شاخص های ید رسانی در افراد بالای ۴۰ سال شهر تهران در سال ۱۳۷۵: عدم افزایش پرکاری تیروئید پس از مصرف نمک یددار**

ناهید سالارکیا ، حمید ذاکری ، صدیقه سهیلی خواه ، ماه طلعت نفرآبادی ، اعظم غروی نوری ، فریدون عزیزی

مجله دانشگاه علوم پزشکی گیلان، شماره ۴۱، بهار ۱۳۸۱ صص ۷-۱۲

۴۳- **تعیین شیوع گواتر و میزان ید ادرار در دانش آموزان ۱۰-۸ ساله استان کرمان در سال ۱۳۷۵**

دکتر حسین دلشاد، دکتر ربابه شیخ الاسلام، پروین میر میران، دکتر گیتا عبدالحسینی، مهدی هدایتی و دکتر فریدون عزیزی

مجله دانشگاه علوم پزشکی کرمان، سال نهم، شماره ۱، زمستان ۱۳۸۰ صص ۱-۶

۴۴- **پایش شیوع گواتر و میزان ید ادرار در دانش آموزان ۸ تا ۱۰ ساله استان سمنان در سال ۱۳۷۵**

پروین میرمیران ، ربابه شیخ السلام، مهدی هدایتی، رامبد حاجی پور، نرگس سربازی، فریدون عزیزی

فصلنامه پژوهش در پزشکی ، سال بیست و ششم، شماره ۱، بهار ۱۳۸۱ ص ۱۱

۴۵- **پایش شیوع گواتر و میزان ید ادرار در دانش آموزان ۸ تا ۱۰ ساله استان گیلان در سال ۱۳۷۵**

فریدون عزیزی ، ربابه شیخ الاسلام ، مهدی هدایتی ، پروین میرمیران ، جمشید بهلکه ، سیدمسعود کیمیاگر ، حسین دلشاد

مجله دانشگاه علوم پزشکی گیلان، شماره ۴۰، زمستان ۱۳۸۰ صص ۸-۱۵

۴۶- **پایش شیوع گواتر ومیزان ید ادرار در دانش آموزان ۸ تا ۱۰ ساله استان کردستان در سال ۱۳۷۵**

دکتر رامبد حاجی‌پور، دکتر ربابه شیخ‌الاسلام ، گیتی عباسی ، دکتر علیرضا مهدوی، پروین میرمیران ، دکتر فریدون عزیزی

مجله علمی دانشگاه علوم پزشکی کردستان، شماره ۱۹، بهار ۱۳۸۰ ص ۲۸

۴۷- **بررسی میزان ید ادرار کودکان ۱۰- ۸ ساله در مدارس تحت پوشش دانشگاه علوم پزشکی ایران در سال تحصیلی ۹۴-۱۳۹۳**

فرانک رحیمی بیرانوند، لیلا فرزاد، طناز شعاعی *، احمد جنیدی جعفری، معصومه گشتائی

مجله علوم پزشکی رازی، شماره ۱۵۱، دی ۱۳۹۵ صص ۶۸-۷۶

۴۸- **بررسی میزان ید موجود در نمک های عرضه شده در شهر کرمانشاه، سال ۹۲- ۱۳۹۱**

یحیی پاسدار، قباد محمدی، امیرمحمد منصوری، شکوفه القاصی، میترا دربندی ، مجید محمودی ، پریسا نیازی

مجله دانشگاه علوم پزشکی مازندران، شماره ۱۳۵، فروردین۱۳۹۵ صص ۱۴۴

۴۹- **بررسی ید دفعی ادرار در دوران بارداری در مناطق شهری شهرستان ارومیه در سال۱۳۹۲**

وحیده جلیلی، زهرا اشرفی، رسول انتظار مهدی، حمیدرضا خلخالی ، جعفر نوروززاده *

مجله دانشگاه علوم پزشکی شهید صدوقی یزد، شماره ۱۱۲، بهمن ۱۳۹۴ صص ۱۰۷۶-۱۰۸۳

۵۰- **بررسی سطح ید ادراری در زنان باردار ساکن تهران**

فاطمه گل گیری ، زهره دهقانی

مجله دانشگاه علوم پزشکی بابل، شماره ۹۳، خرداد ۱۳۹۴ صص ۱۳-۱۸

۵۱- **تغییرات تیروئید در حاملگی**

دکتر فریدون عزیزی ، دکتر حسین دلشاد

مجله غدد درون ریز و متابولیسم ایران، شماره ۷۲، اسفند ۱۳۹۲ صص ۴۹۱-۵۰۸

۵۲- **ارزیابی سطح هورمون محرک تیروئید و ید دفعی ادرار در زنان باردار شهرستان ارومیه**

رحیم رستمی، اصغر بیرانون، زهرا اشرفی ، جعفر نوروززاده

مجله پزشکی ارومیه، سال بیست و چهارم، شماره ۱۰، دی ۱۳۹۲ صص ۷۴۵-۷۵

۵۳- **بررسی میزان شیوع گواتر و وضعیت نسبت ید بر کراتینین در دختران مدارس شهرستان ارومیه**

رحیم رستمی ، اصغر بیرانوند ، حمیده استبرق نیا ، محمدرضا آقاصی ، جعفر نوروززاده

مجله دانشگاه علوم پزشکی شهید صدوقی یزد، شماره ۸۹، بهمن و اسفند ۱۳۹۱ ص ۷۳۲

۵۴- **بررسی سطح ید دریافتی زنان باردار شهرستان ارومیه: ارتباط با کیفیت و نحوه استفاده از نمک یدار**

دکتر جعفر نوروززاده، اصغر بیرانوند ، رحیم رستمی ، دکتر شاکر سالاری لک

مجله پزشکی ارومیه، سال بیست و سوم، شماره ۴، مهر و آبان ۱۳۹۱ صص ۴۴۰-۴۴۵

۵۵- **تاریخچه و وضعیت کمبود ید در جهان و ایران**

دکتر حسین دلشاد

مجله غدد درون ریز و متابولیسم ایران، شماره ۳۶، زمستان ۱۳۸۶ صص ۴۳۹-۴۵۴

۵۶- **بررسی اثر سوء تغذیه در باقی ماندن گواتر اندمیک علیرغم دریافت ید کافی**

دکتر مجید امین زاده ، دکتر زهره کرمی زاده ، دکتر غلامحسین امیرحکیمی ، مرضیه وکیلی

مجله بیماریهای کودکان ایران، سال هفدهم، شماره ۱، بهار ۱۳۸۶ ص ۶۷

۵۷- **مقایسه شیوع گواتر در مردان و زنان: یک متاآنالیز**

دکتر رامین ملبوس باف ، دکتر فرهاد حسین پناه ، دکتر فریدون عزیزی ، مهدی مجرد، سارا جام بر سنگ

مجله غدد درون ریز و متابولیسم ایران، شماره ۵۴، اسفند ۱۳۸۹ ص ۶۴۱

۵۸- **مقایسه آنتی تیروئید آنتی بادی ها و میزان ید ادراری در افراد هیپوتیروئید**

غلامرضام اسدی کر، مسعود ترکزاده ماهانی

مجله دانشگاه علوم پزشکی رفسنجان، سال نهم، شماره ۴، زمستان ۱۳۸۹ ص ۲۶۳

۵۹- **بررسی ارتباط گواتر آندمیک و عادات تغذیه ای در دانش آموزان دبیرستان های دولتی شهر خوی**

رقیه صدیقی ، فائزه صحبائی ، دکتر ژاسمن شاه نظریان

مجله دانشکده پرستاری و مامایی همدان، شماره ۲۸، پاییز و زمستان ۱۳۸۶ ص ۲۸

۶۰- **بررسی ید ادرار و ید شیر در نوزادان هیپوتیروئید و مادرانشان و مقایسه آن با گروه کنترل**

پیمان نصری، دکتر مهین هاشمی پور ، سیلوا هوسپیان، مسعود امینی، کمال حیدری، سیدعلی سجادی، علی عجمی، حسین موحدیان عطار، معصومه داستان پور، رضوانه هادیان، لیلی موهبت

مجله غدد درون ریز و متابولیسم ایران، شماره ۴۵، شهریور ۱۳۸۸ ص ۲۶۵

۶۱- **تعیین حجم تیروئید به وسیله اولترا سونوگرافی در کودکان ۱۰ – ۷ ساله شهرستان بوشهر ۱۳۸۶**

آقای فرزاد مرادحاصلی، آقای ایرج نبی پور ، آقای مجید اسدی، آقای سیروس عباسی

مجله طب جنوب، سال یازدهم، شماره ۲، اسفند ۱۳۸۷ ص ۱۷۰

تاثیر کنترل ید نمک بر غلظت ید ادرار دانش آموزان ۱۰-۸ ساله استان آذربایجان شرقی

دکتراحمد کوشا، سویل حکیمی، دکتر قشم سلیمان زاده، ناهید هاشم نیا، حسن فرهاد غیبی

مجله پزشکی دانشگاه علوم پزشکی و خدمات بهداشتی درمانی تبریز، شماره ۷۹، پاییز ۱۳۸۷ ص ۱۴۵

میزان شیوع هیپوتیروئیدی مادرزادی و افزایش گذرای TSH در استان یزد

محمود نوری شادکام، مجید جعفریزاده، محسن میرزایی، محمد اسماعیل مطلق، ضیاء اسلامی، محمد افخمی اردکانی، محمدحسن لطفی، محمدرضا صادقیان۸، آذر ربیعی، حسین شجاعی فر

مجله دانشگاه علوم پزشکی شهید صدوقی یزد، شماره ۶۴، پاییز ۱۳۸۷ ص ۱۵

۶۴- **بررسی میزان پایداری ید موجود در نمکهای یددار در برابر نور و رطوبت در شهر دامغان در سال ۱۳۸۴**

سیده حوریه فلاح، دکتر نرگس کلانتری، سید محمود مهدی نیا، ندا طاهری روزبهانی، نوشین بابایی

مجله دانشگاه علوم پزشکی اردبیل، شماره ۲۷، بهار ۱۳۸۷ ص ۷۲

۶۵- **بررسی میزان شیوع گواتر و تیروئیدیت اتوایمیون در دانش آموزان ۱۰ سال بعد از دریافت مناسب و طبیعی ید**

دکتر محمدحسین دباغ منش ، دکتر عبدالصمد صادق الوعد، دکتر فرداد اجتهادی، دکتر غلامحسین عمرانی

مجله غدد درون ریز و متابولیسم ایران، شماره ۳۴، تابستان ۱۳۸۶ ص ۱۴۹

۶۶- **بررسی میزان شیوع گواتر و ارتباط آن با عملکرد تیروئید در کودکان دبستانی شهر سمنان (سال ۱۳۸۴)**

مریم سیف هاشمی، راهب قربانی ، میرمحمدعلی علوی

فصلنامه کومش، شماره ۲۵، پاییز ۱۳۸۶ ص ۳۳

۶۷- **بررسی حجم غده تیروئید بوسیله اولتراسونوگرافی و ارتباط آن با سطح ید ادرار دانش آموزان پسر ۱۵-۱۲ ساله مقطع راهنمایی شهرستان تبریز در سال ۱۳۸۳**

دکتر سلطانعلی محبوب ، مجید محمد شاهی،دکتر ابوالحسن شاکری، دکتر علیرضا استادرحیمی ، سید جمال قائم مقامی ، فاطمه حیدری

مجله دانشگاه علوم پزشکی اردبیل، شماره ۲۴، تابستان ۱۳۸۶ ص ۱۶۹

۶۸- **بررسی اثر سوء تغذیه در باقی ماندن گواتر اندمیک علیرغم دریافت ید کافی**

دکتر مجید امین زاده ، دکتر زهره کرمی زاده ، دکتر غلامحسین امیرحکیمی ، مرضیه وکیلی

مجله بیماریهای کودکان ایران، سال هفدهم، شماره ۱، بهار ۱۳۸۶ ص ۶۷

۶۹- **آیا کمبود آهن علت شیوع گواتر آندمیک در منطقه ی سمیرم است**

دکتر حسن رضوانیان ، دکتر مهین هاشمی پور ، دکتر اشرف امین الرعایا ، دکتر علی کچویی ، دکتر محمدحسن

مودب ، دکتر منصور سیاوش ، دکتر سیدمحمد محمدی ، دکتر ساسان حقیقی ، دکتر مسعود امینی

مجله غدد درون ریز و متابولیسم ایران، شماره ۳۲، زمستان ۱۳۸۵ صص ۳۵۱-۳۵۶

۷۰- **بررسی شیوع گواتر و کمبود ید ۱۰ سال پس از شروع ید دار کردن نمک طعام در دانش آموزان ۸ تا ۱۳ ساله شهرستان مرودشت**

دکتر عبدالصمد صادق الوعد ، دکتر محمدحسین دباغ منش ، دکتر فرداد اجتهادی ، دکتر غلامحسین رنجبر عمرانی

مجله غدد درون ریز و متابولیسم ایران، شماره ۲۹، بهار ۱۳۸۵ ص ۱

۷۱- **بررسی ید ادراری و شیوع گواتر بالینی در دانش آموزان ۱۲-۸ ساله سمیرم اصفهان در سال ۸۳ (۱۵ سال پس از اجرای برنامه کشوری مبارزه با اختلالات ناشی از کمبود ید)**

علی کچوئی ، مهین هاشمی پور ، حسن رضوانیان ، اشرف امین الرعایا ، مسعود امینی ، ساسان حقیقی

مجله دانشگاه علوم پزشکی مازندران، شماره ۵۳، مرداد و شهریور ۱۳۸۵ صص ۸۶-۹۱

۷۲- **بررسی مقایسه ای قد و وزن کودکان دبستانی قبل و ۲/۵ سال پس از تزریق لیپیدول در یک منطقه گواتر آندمیک**

ایرج ملکی، زهرا کاشی

مجله دانشگاه علوم پزشکی مازندران، شماره ۵۰، بهمن و اسفند ۱۳۸۴ صص ۳۵-۴۰

۷۳- **توزیع ید در ادرار و شیر مادران در دوران پس از زایمان در گرگان ، سال ۱۳۸۲**

حمیدرضا بذرافشان ، سکینه محمدیان ، آرش اردوخانی ، آرزو عابدینی ، رضا داوودی ، مهدی هدایتی ، فریدون عزیزی

فصلنامه پژوهش در پزشکی ، سال بیست و نهم، شماره ۲، تابستان۱۳۸۴ ص ۱۶۹

۷۴- **بررسی شاخص های آناتومی غده تیروئید طبیعی در بالغین شهرستان اصفهان**

دکتر ابراهیم اسفندیاری ، دکتر مسعود امینی ، دکتر عباسعلی ربیعی ، دکتر حامد مهدی نژاد گرجی ، دکتر سیدمیثم موسوی ، دکتر ثمانه احمدیان مقدم ، دکتر مینو رمضانزاده یزدی ، دکتر سیلوا هوسپیان ، دکتر ساسان حقیقی

مجله علوم پایه پزشکی ایران، شماره ۲۶، تابستان ۱۳۸۴ ص ۷۵

۷۵- **بررسی میزان ید در نمک های یددار توزیع شده در استان سمنان در پاییز ۱۳۸۳**

سیدمحمود مهدی نیا ، حمیدرضا ناصحی نیا ، ربابه قریب بلوک ، راضیه عزیزی ، محمد رضایی

فصلنامه کومش، شماره ۱۸، تابستان ۱۳۸۴ ص ۲۸۵

۷۶- **ارزیابی ید ادراری و TSH خون در زنان باردار مراجعه کننده به درمانگاه سرپایی مرکز آموزشی - درمانی دزیانی گرگان در سال ۱۳۸۲**

دکتر سپیده بخشنده نصرت ، دکتر حمیدرضا بذرافشان ، محمدرضا ربیعی ، دکتر نرجس سادات عقیلی

مجله دانشگاه علوم پزشکی گرگان، شماره ۱۴، پاییز و زمستان ۱۳۸۳ صص ۷۸-۸۲

۷۷- **بررسی شیوع گواتر و میزان ید ادرار در دانش آموزان ۶ تا ۱۰ ساله شهر اهواز در سال ۱۳۸۱**

دکتر حاجیه شهبازیان ، سعید سعیدی نیا

مجله علمی پزشکی جندی شاپور، شماره ۴۴، خرداد ۱۳۸۴ ص ۶۱

۷۸- **تغییرات وابسته به سن و جنس در شیوع گواتر کودکان دبستانی در گرگان یک دهه پس از یدرسانی همگانی**

حمیدرضا بذرافشان ، سکینه محمدیان ، آرش اردوخانی ، نفیسه عبداللهی ، مهدی هدایتی ، فریدون عزیزی

مجله غدد درون ریز و متابولیسم ایران، شماره ۲۵، بهار ۱۳۸۴ ص ۵

۷۹- **بررسی تاثیر مکمل های آهن ، ید و توام آنها بر وضعیت هورمونی تیروئید دختران نوجوان مبتلا به فقر آهن**

محمدحسن افتخاری ؛ نوید سعادت ؛ محمود جلالی ؛ سید علی کشاورز ؛ محمدرضا اشراقیان ؛ آمیتیس بهرامیان

مجله غدد درون ریز و متابولیسم ایران، شماره ۲۳، پاییز ۱۳۸۳ ص ۱۸۱

۸۰- **غربالگری نوزادان برای شناسایی کم کاری مادرزادی تیروئید در رشت**

دکتر سعید کلانتری

مجله دانشگاه علوم پزشکی گیلان، شماره ۵۰، تابستان ۱۳۸۳ ص ۷۶

۸۱- **شیوع گواتر و ید ادرار در دانش آموزان ۱۱-۶ ساله شهر یزد در سال ۱۳۸۱**

دکتر حسن مظفری خسروی ، علی دهقانی ، دکتر محمد افخمی

مجله دانشگاه علوم پزشکی رفسنجان، سال سوم، شماره ۲، بهار ۱۳۸۳ ص ۹۶

۸۲- **مطالعه شیوع گواتر و میزان ید ادرار در دانش آموزان ۱۱-۶ ساله استان یزد در سال ۱۳۸۱ ، ۱۰ سال بعد از شروع طرح نمک یددار**

حسن نظفری خسروی ، علی دهقانی ، محمد افخمی

مجله غدد درون ریز و متابولیسم ایران، شماره ۲۰، زمستان ۱۳۸۲

۸۳- **نمای بالینی اولیه کم کاری تیروئید در ناحیه آندمیک ید (قائم شهر و بابل)**

دکتر بهزاد حیدری ؛ دکتر شهریار سوادکوهی

مجله دانشگاه علوم پزشکی بابل، شماره ۲۰، پاییز ۱۳۸۲ ص ۲۷

۸۴- **شیوع گواتر ۹ سال پس از مصرف نمک یددار در دانش آموزان ابتدایی کرمانشاه (سال ۱۳۷۹)**

دکتر قباد سلیمی، دکتر هادی خرازی، دکتر افسانه سالکی، مهندس امیرحسین هاشمیان

مجله علوم پزشکی کرمانشاه، سال هفتم، شماره ۳، پاییز ۱۳۸۲ ص ۱

۸۵- **میزان ید ادرار دانش اموزان نیشابور**

جمشید مهرزاد ، علیرضا متولی زاده کاخکی

مجله پزشکی کوثر، شماره ۲۷، بهار ۱۳۸۲ ص ۳

۸۶- **عوارض پوستی آمپول Lipiidol در شهر خرم آباد**

دکتر بهرام دلفان ، دکتر رقیه جبرئیلی ، مهناز مردانی ، دکتر اکبر کردی ، حسن نیکنام

فصلنامه یافته، شماره ۱۶، بهار ۱۳۸۲ ص ۳۵

۸۷- **گواتر هیپراندمیک در واریز رفسنجان ، احتمال وجود گواتر و ژن های ناشناخته**

دکتر غلامرضا اسدی کرم ، دکتر سید محمدعلی سجادی ، محسن رضائیان ، محمدرضا وفا ، دکتر عباس اسماعیلی ، محمد مرادی

مجله دانشگاه علوم پزشکی رفسنجان، سال اول، شماره ۲، بهار ۱۳۸۱ ص ۷۹

۸۸- **بررسی میزان شیوع گواتر و کمبود ید در دختران دانش آموز ۱۸-۱۴ ساله شهر شیراز ۱۳۷۶**

شهناز روان شاد ، فروز نادر ، اسفندیار ستوده مرام ، حبیب اله مصطفوی

مجله پزشکی دانشگاه علوم پزشکی و خدمات بهداشتی درمانی تبریز، شماره ۵۰، تابستان ۱۳۸۰ صص ۴۱-۴۶

۸۹- **وضعیت بیماری های غدد درون ریز و متابولیسم در کشور سال ۱۳۸۰**

فریدون عزیزی

مجله غدد درون ریز و متابولیسم ایران، شماره ۱۰، بهار ۱۳۸۰ ص ۷۹

۹۰- **بررسی ارتباط بین فریتین سرم و گواتر، میزان ید ادرار و غلظت سرمی هورمون های تیروئید در دانش آموزان کشور**

فریدون عزیزی ، پروین میرمیران ، ربابه شیخ الاسلام ، مهدی هدایتی ، رضا راست منش

مجله غدد درون ریز و متابولیسم ایران، شماره ۱۰، بهار ۱۳۸۰ ص ۸۹

۹۱- **در جستجوی شاخص مطمئنی برای پایش یدرسانی**

پروین میرمیران ، مازیار رحمانی، ربابه شیخ الاسلام، مهدی هدایتی، فریدون عزیزی

فصلنامه پژوهش در پزشکی ، سال بیست و پنجم، شماره ۲، تابستان ۱۳۸۰ ص ۱

۹۲- **تاثیر نمک یددار بر هورمونهای تیروئید، ید ادرار و درجه گواتر در منطقه شهریار**

لیدا نوایی، دکتر فرید فتاحی، ماه طلعت نفرآبادی، دکترفریدون عزیزی

مجله غدد درون ریز و متابولیسم ایران، شماره ۷، پاییز ۱۳۷۹ ص ۱۹۱

۹۳- **شاخص های کمبود ید شش سال پس از تجویز ید در دانش آموزان دختر روستای آهار**

ناهید سالارکیا ، مهدی هدایتی ، دکتر فریدون عزیزی

مجله دانشگاه علوم پزشکی زنجان ، شماره ۳۹، زمستان ۱۳۸۱ ص ۳۵

مجموعه مقالات انگلیسی منتشر شده در ارتباط با کمبود ید در ایران

1- Environmental iodine intake affects the response to methimazole in patients with diffuse toxic goiter.

Azizi F.

J Clin Endocrinol Metab. 1985 Aug; 61(2):374-7

2- Survey of iodine deficiency in a rural area near Tehran: association of food intake and endemic goitre.

Kimiagar M, Azizi F, Navai L, Yassai M, Nafarabadi T.

Eur J Clin Nutr. 1990 Jan; 44(1):17-22

3- Impairment of neuromotor and cognitive development in iodine-deficient schoolchildren with normal physical growth.

Azizi F, Sarshar A, Nafarabadi M, Ghazi A, Kimiagar M, Noohi S, Rahbar N, Bahrami A, Kalantari S.

Acta Endocrinol (Copenh). 1993 Dec; 129(6):501-4

4- Physical, neuromotor and intellectual impairment in non-cretinous schoolchildren with iodine deficiency.

Azizi F, Kalani H, Kimiagar M, Ghazi A, Sarshar A, Nafarabadi M, Rahbar N, Noohi S, Mohajer M, Yassai M.

Int J Vitam Nutr Res. 1995; 65(3):199-205

5- Treatment of goitrous hypothyroidism with iodized oil supplementation in an area of iodine deficiency.

Azizi F, Kimiagar M, Ghazi A, Nafarabadi M, Behjati J, Esfahanian F.

Exp Clin Endocrinol Diabetes. 1996; 104(5):387-91

6- The effects of iodized oil injection in eu- and hypothyroid iodine deficient girls.

Azizi F, Kimiagar M, Ghazi AA, Nafarabadi M.

J Endocrinol Invest. 1997 Jan; 20(1):18-23.

7- Monitoring iodine following consumption of iodized salt in Tehrani inhabitants.

Salarkia N, Azizi F, Kimiagar M, Zakeri H, Soheilikhah S, Nafarabadi M.

Int J Vitam Nutr Res. 2000 Mar;70(2):65-9.

8- Thyroid volumes in schoolchildren of Tehran: comparison with European schoolchildren.

Azizi F, Delshad H, Mehrabi Y.

J Endocrinol Invest. 2001 Nov; 24(10):756-62.

9- Side-effects of iodized oil administration in patients with simple goiter.

Azizi F, Daftarian N.

J Endocrinol Invest. 2001 Feb; 24(2):72-7

10- Sustainable control of iodinedeficiency in Iran: beneficial results of the implementation of the mandatory law on salt iodization.

Azizi F, Sheikholeslam R, Hedayati M, Mirmiran P, Malekafzali H, Kimiagar M, Pajouhi M.

J Endocrinol Invest. 2002 May; 25(5):409-13

11- Three-year survey of effects of iodized oil injection in schoolchildren with iodine deficiency disorders.

Mirmiran P, Kimiagar M, Azizi F.

Exp Clin Endocrinol Diabetes. 2002 Nov;110(8):393-7.

12- Goiter prevalence, urinary iodine excretion, thyroid function and anti-thyroid function and anti-thyroid antibodies after 12 years of salt iodization in Shahriar, Iran.

Azizi F, Navai L, Fattahi F.

Int J Vitam Nutr Res. 2002 Oct; 72(5):291-

13- Congenital hypothyroidism in Iran.

Ordookhani A, Mirmiran P, Najafi R, Hedayati M, Azizi F.

Indian J Pediatr. 2003 Aug; 70(8):625-8

14- Iodized salt consumption maintains euthyroidism in iodine-deficient hypothyroid subjects.

Mirmiran P, Hajipour R, Azizi F.

Int J Vitam Nutr Res. 2003 May;73(3):187-91

15- Urinary iodine excretion in pregnant women residing in areas with adequate iodine intake.

Azizi F, Aminorroya A, Hedayati M, Rezvanian H, Amini M, Mirmiran P.

Public Health Nutr. 2003 Feb;6(1):95-8

16- Evaluation of the impact of an iodine supplementation programme on severely iodine-deficient schoolchildren with hypothyroidism.

Salarkia N, Hedayati M, Mirmiran P, Kimiagar M, Azizi F.

Public Health Nutr. 2003 Sep; 6(6):529-33.

17- Experiences in the prevention, control and elimination of iodine deficiency disorders: a regional perspective.

Azizi F, Mehran L.

East Mediterr Health J. 2004 Nov; 10(6):761-70. Review

18- Effect of 10 yr of the iodine supplementation on the hearing threshold of iodine deficient schoolchildren.

Azizi F, Mirmiran P, Hedayati M, Salarkia N, Noohi S, Rostamian D.

J Endocrinol Invest. 2005 Jul-Aug; 28(7):595-8

19- An assessment of urinary and breast milk iodine concentrations in lactating mothers from Gorgan, Iran, 2003.

Bazrafshan HR, Mohammadian S, Ordookhani A, Abedini A, Davoudy R, Pearce EN, Hedayati M, Azizi F, Braverman LE.

Thyroid. 2005 Oct; 15(10):1165-8.

20- Prevalence of goiter among schoolchildren from Gorgan, Iran, a decade after national iodine supplementation: association with age, gender, and thyroperoxidase antibodies.

Bazrafshan HR, Mohammadian S, Ordookhani A, Farhidmehr F, Hedayati M ,

Abdolahi N, Azizi F, Braverman LE, Pearce EN.

J Endocrinol Invest. 2005 Sep; 28(8):727-33

21- Assessment of intertrimester and seasonal variations of urinary iodine concentration during pregnancy in an iodine-replete area.

Ainy E, Ordookhani A, Hedayati M, Azizi F.

Clin Endocrinol (Oxf). 2007 Oct; 67(4):577-81.

22- Goiter rate, serum thyrotropin, thyroid autoantibodies and urinary iodine concentration in Tehranian adults before and after national salt iodization.

Heydarian P, Ordookhani A, Azizi F.

J Endocrinol Invest. 2007 May; 30(5):404-10.

23- Assessment of thyroid function and urinary and breast milk iodine concentrations in healthy newborns and their mothers in Tehran.

Ordookhani A, Pearce EN, Hedayati M, Mirmiran P, Salimi S, Azizi F, Braverman LE.

Clin Endocrinol (Oxf). 2007 Aug; 67(2):175-9. Epub 2007 Apr 27.

24- Iodine nutrition in pregnancy and lactation in Iran.

Azizi F.

Public Health Nutr. 2007 Dec;10(12A):1596-9.

25- Transient congenital hypothyroidism in an iodine-replete area is not related to parental consanguinity, mode of delivery, goitrogens, iodine exposure, or thyrotropin receptor autoantibodies.

Ordookhani A, Pearce EN, Mirmiran P, Azizi F, Braverman LE.

J Endocrinol Invest. 2008 Jan; 31(1):29-34.

26- Sustainability of a well-monitored salt iodization program in Iran: marked reduction in goiter prevalence and eventual normalization of urinary iodine concentrations without alteration in iodine content of salt.

Azizi F, Mehran L, Sheikholeslam R, Ordookhani A, Naghavi M, Hedayati M, Padyab M, Mirmiran P.

J Endocrinol Invest. 2008 May; 31(5):422-31.

27- Breastfeeding and maternal and infant iodine nutrition.

Azizi F, Smyth P.

Clin Endocrinol (Oxf). 2009 May; 70(5):803-9.

28- Appropriate iodine nutrition in Iran: 20 years of success.

Delshad H, Mehran L, Azizi F

Acta Med Iran. 2010 Nov-Dec; 48(6):361-6.

29- Evaluation of iodine nutritional status in Tehran, Iran: iodine deficiency within iodine sufficiency.

Nazeri P, Mirmiran P, Mehrabi Y, Hedayati M, Delshad H, Azizi F.

Thyroid. 2010 Dec; 20(12):1399-406.

30- Neonatal thyroid status in an area of iodine sufficiency.

Azizi F, Hosseini MS, Amouzegar A, Tohidi M, Ainy E.

J Endocrinol Invest. 2011 Mar; 34(3):197-200.

31- Is placental iodine content related to dietary iodine intake?

Burns R, Azizi F, Hedayati M, Mirmiran P, O'Herlihy C, Smyth PP.

Clin Endocrinol (Oxf). 2011 Aug; 75(2):261-4.

32- Eighteen years of continuously sustained elimination of iodine deficiency in the Islamic Republic of Iran: the vitality of periodic monitoring.

Delshad H, Amouzegar A, Mirmiran P, Mehran L, Azizi F.

Thyroid. 2012 Apr; 22(4):415-21.

33- Does a text messaging intervention improve knowledge, attitudes and practice regarding iodine deficiency and iodized salt consumption?

Mehran L, Nazeri P, Delshad H, Mirmiran P, Mehrabi Y, Azizi F.

Public Health Nutr. 2012 Dec;15(12):2320-5.

34- Iron, iodine and vitamin a in the middle East; a systematic review of deficiency and food fortification.

Mirmiran P, Golzarand M, Serra-Majem L, Azizi F.

Iran J Public Health. 2012; 41(8):8-19. Epub 2012 Aug 31.

35- Natural course of thyroid disease profile in a population in nutrition transition: Tehran Thyroid Study.

Azizi F, Amouzegar A, Delshad H, Tohidi M, Mehran L, Mehrabi Y.

Arch Iran Med. 2013 Jul; 16(7):418-23.

36- Iodine nutrition status and knowledge, attitude, and behavior in Tehranian women following 2 decades without public education.

Mirmiran P, Nazeri P, Amiri P, Mehran L, Shakeri N, Azizi F.

J Nutr Educ Behav. 2013 Sep-Oct; 45(5):412-9.

37- An assessment of the iodine status and the correlation between iodine nutrition and thyroid function during pregnancy in an iodine sufficient area.

Amouzegar A, Khazan M, Hedayati M, Azizi F.

Eur J Clin Nutr. 2014 Mar; 68(3):397-400.

38- Mothers' behaviour contributes to suboptimal iodine status of family members: findings from an iodine-sufficient area.

Nazeri P, Mirmiran P, Asghari G, Shiva N, Mehrabi Y, Azizi F.

Public Health Nutr. 2015 Mar; 18(4):686-94.

39- Iodine nutrition status in lactating mothers residing in countries with mandatory and voluntary iodine fortification programs: an updated systematic review.

Nazeri P, Mirmiran P, Shiva N, Mehrabi Y, Mojarrad M, Azizi F.

Thyroid. 2015 Jun; 25(6):611-20.

40- Iodine Status in Pregnant Women, Lactating Mothers, and Newborns in an Area with More Than Two Decades of Successful Iodine Nutrition.

Nazeri P, Zarghani NH, Mirmiran P, Hedayati M, Mehrabi Y, Azizi F.

Biol Trace Elem Res. 2016 Jul;172(1):79-85.

41- Inadequate iodine nutrition of pregnant women in an area of iodine sufficiency.

Delshad H, Touhidi M, Abdollahi Z, Hedayati M, Salehi F, Azizi F.

J Endocrinol Invest. 2016 Jul;39(7):755-62.

42- Neonatal thyrotropin concentration and iodine nutrition status of mothers: a systematic review and meta-analysis.

Nazeri P, Mirmiran P, Kabir A, Azizi F.

Am J Clin Nutr. 2016 Dec; 104(6):1628-1638.

43- The Effects of Iodine Fortified Milk on the Iodine Status of Lactating Mothers and Infants in an Area with a Successful Salt Iodization Program: A Randomized Controlled Trial.

Nazeri P, Mirmiran P, Tahmasebinejad Z, Hedayati M, Delshad H, Azizi F.

Nutrients. 2017 Feb 22; 9(2).

44- Iodine deficiency status in the WHO Eastern Mediterranean Region: a systematic review.

Mohammadi M, Azizi F, Hedayati M.

Environ Geochem Health. 2017 Feb 21.

مقاله پنجمین پایش ملی اختلال های ناشی از کمبود ید در ایران

Continuously sustained elimination of iodine deficiency: A quarter of century success in the Islamic Republic of Iran

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Abstract:

Background: Iodine deficiency and related disorders were very common in Iran prior to 1996, when universal salt iodization (USI) was implemented and in 2000 Iran was declared iodine deficiency disorders (IDD) free. The aim of this study was to evaluate the adequacy of iodine intake by Iranian households in all 30 provinces of Iran, a quarter of century after intervention.

Methods: A total of 18,000 school aged children (8-10 years with mean 8.7±1 year) were included in this study. Urine samples were collected from all children for measurement of urinary iodine excretion and 1800, 210 and 3000 salt samples were randomly collected from the family kitchen, production site of 73 salt factories and distribution circles of 30 provinces, respectively.

Results: Median urinary iodine concentration (UIC) of participants was 161µg/L. The proportion of children with UIC of, 20-49, 50-99 and ≥100µg/L were 10.3, 15.9 and 73.7%, respectively. The mean (± SD) and median salt iodine values were 28.2 (± 12.6) and 31.7 ppm, at the production site, and 31.5 (±13.6) and 29.6 ppm at the distribution circles,

respectively. About 80% of factory salts had more than 20 ppm iodine. 98% of households consumed iodized salt, 80% had appropriate salt storage, and 83% of the household salts contained ≥20 ppm.

Conclusions: Based on the results of this study, Iranian populations are consuming adequate iodine. The well maintained and monitored USI program has improved dietary iodine intakes of the population and the country has achieved all criteria of a well controlled IDD program.

Introduction:

As an essential nutrient, iodine is required for the production of thyroid hormones (1). Since the body does not make iodine, it relies on the diet for sufficient iodine intake. The main cause of iodine deficiency is low iodine content in the diet. Severe iodine deficiency has adverse effects on the mean intelligence quotient of population (2) and iodine supplementation could increase the intelligent quotient in children affected from iodine deficiency (3). Low iodine intake is the main cause of preventable mental retardation. Worldwide efforts by international agencies resulted in achieving iodine sufficiency by the year 2005 (4–7), although many countries, even in industrialized ones are still iodine deficient (8–12). Universal salt iodization as a safe, cost-effective and sustainable strategy was recommended by the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF) in 1994 to ensure sufficient intake of iodine by all individuals. Over the last century, considerable efforts world-wide have been paid to control this nutritional problem, but still many countries in the world are iodine deficient. Globally, 29.8% of school-age children (246 million) are estimated to have insufficient iodine intake. During past decade the number of iodine deficient countries has decreased from 54 to 30 while iodine-sufficient ones have increased from 67 to 112; the number of countries with

excessive iodine intake has increased from 5 to 10. Although worldwide, 90% of households consume adequately iodized salt, consumption is still below 50% in 39 countries (13-15).

In Iran iodine deficiency was common in most of its regions with moderate to severe endemic goiter, cretinism, retarded brain and mental development being common in the many parts of the country (16, 17). Deficiency in iodine nutrition despite being recognized in Iran since 1968 (18), was not categorizes as a public health problem until 1980. The National Iranian Committee for Control of IDD was formed in 1989 and since then USI has resulted in sustainable preventive programs of IDDs, leading to great success in IDD control and elimination. In 2000, I.R Iran had recognized as an iodine sufficient country by WHO Eastern Mediterranean Regional Office (19).

The sustainability of iodine sufficiency is the major concern after achieving criteria of iodine repletion (20, 21). A false sense of the iodine sufficiency of population is the major cause of failure in iodine deficiency elimination programs (22). The National Iranian Committee for Control of IDD has scheduled control programs every 5-6 years to evaluate the sustainability of the program. This study aimed confirming updated data on iodine nutrition among schoolchildren in the I.R. Iran.

Materials and methods

A cross-sectional cluster survey among schoolchildren aged 8-10 years was conducted between October 2013 and February 2014, using recommended standard methods and approaches. Urinary iodine levels and the amount of iodine content of salt were measured among schoolchildren, at factories, distribution sites and households. The survey protocol was reviewed and approved by the ethics committee of the Research Institute of Endocrine Sciences (RIES) affiliated to Shahid Beheshti University of Medical Sciences.

Subjects and sampling

Urinary iodine concentration

For urinary iodine determination, 600 subjects, equal number of girls and boys, i.e 30 clusters of schoolchildren (n=20each), aged 8–10 years were selected in each province. Thirty primary schools were selected proportionate to population size (23) in each province from the national database maintained by the Ministry of Education; and twenty children, aged 8–10 years were sampled at random in each school. From 30 provinces of the country, urine samples of overall 18,000 schoolchildren (equal numbers of rural and urban) were obtained. These samples were transferred in screw-top plastic bottles on ice to the RIES laboratory and kept frozen at –20 C until the time of iodine measurement at the end of the study. Verbal consent was obtained from the parents of participating children. All participants were requested to bring a salt sample from their house, with the brand name written on it.

From salt factories, five samples from different parts of each of the 73 iodized salt producing factories, and 100 samples from distribution sites in each province were collected and sent to the food and drug control laboratory of the health center in each province. At the measurement site, a small portion of the salt was tested with a rapid test kit (MBI Kits, India). Salt envelopes were marked with the subjects' unique codes and samples were delivered to the laboratory of the Research Institute for Endocrine Sciences for measuring the iodine content by titration. Quantitative iodine measurement was performed at the center. Samples of iodized salt for household use (1800 samples from all provinces) were collected for quality and quantity control, and the content of household salt was measured in the field, using rapid testing kits (24). Approximately 10% of salt samples were randomly selected and transferred to the laboratory for food and drug control of the health center in each province for iodometric titration.

Laboratory measurement

Three trained technicians measured iodine concentration of all urine samples using the acid digestion method at the RIES laboratory, (25, 26). The intra-assay coefficient of variation (CV) of the UIC measurement method for concentrations of 3.5, 15, and 38µg/L was 11.2, 8.2, and 9.4%, respectively, and the inter-assay CV values for these concentrations were 12.5, 8.9, and 10.3%, respectively. Iodometric titration assay was used for quantitative salt iodine measurements (27) and values are shown in parts per million (ppm). The reaction mechanism for iodometric titration, includes two steps: (1). Liberation of free iodine from salt by addition of H2SO4 liberates free iodine from the iodate in the salt sample. Then excess KI is added to help solubilize the free iodine, which is quite insoluble in pure water under normal conditions. (2). Titration of free iodine with thiosulfate. Free iodine is consumed by sodium thiosulfate in the titration step. The amount of thiosulfate used is proportional to the amount of free iodine liberated from the salt. Starch is added as an external (indirect) indicator of this reaction, and reacts with free iodine to produce a blue color. When added towards the end of the titration i.e, when only a trace amount of free iodine is left, the loss of blue color, or endpoint, which occurs with further filtration, indicates that all remaining free iodine has been consumed by thiosulfate. This titration method has been standardized by RIES and approved by the Ministry of Health and Medical Education (MHME) for uniform measurement of salt iodine in the laboratories for food and drug control of the health center of each province.

Definitions

Iodine deficiency was considered as a median urinary iodine concentration (UIC) < 100 µg/L. Median UICs of 50–99, 20–49, and < 20 µg/L, were considered mild, moderate, and severe iodine deficiency, respectively, while median UICs of 100–199, 200–299, and > 300 µg/L were considered adequate, more than adequate, and excessive, respectively (28). For salts,

iodine levels of < 20, of 20–40, and of >40 ppm were considered inadequate, adequate, and excessive, respectively.

Statistical analyses

Frequency, percentage, arithmetic mean, median, standard deviation and 95% confidence interval were used to present the data. Appropriate tests of significance ($\chi 2$, Student's t, analysis of variance (ANOVA), and Mann–Whitney U tests) were applied wherever necessary. Correlations between continuous numerical variables were assessed by Spearman's Rank and Pearson coefficients. SPSS 9.05 software package (SPSS, Inc., Chicago, IL) was used for the statistical analysis and $p < 0.05$ was considered significant.

Results

A total of 18,000 school aged children (8-10 years with mean 8.7± 1 year) were included in this study.

Urinary iodine concentration

Median UIC of schoolchildren was 161µg/L. Figure 1 shows median UICs of all provinces in bar graphs compared to previous study; 10.3, 15.9 and 73.7% of children had urinary iodine excretion levels of 20-49, 50-99 and >100µg/L, respectively. There was no significant difference in UICs between boys and girls or between rural and urban areas (Table 1). All provinces had median UIC > 100µg/L.

Salt iodine at production level

The mean (± SD) and median salt iodine at the production level were 28.2 (± 12.6) and 31.7 ppm, respectively. Iodine levels of < 20, of 20–40, and of >40 ppm were observed in 9%, 71%, and 20% of samples, respectively. About 80% of factory salts had > 20 µg/L iodine.

Salt iodine at distribution level

Mean (±SD) and median of iodine level concentrations were 31.5 (±13.6) and 29.6 ppm, respectively, at the distribution level. Iodine levels of < 20, of 20–40, and of > 40 ppm were observed in 11, 59, and 30% of samples, respectively.

Salt iodine at household level

Ninety-eight percent of households consumed iodinated salt of which 82% was crystallized iodized salt. Fifty-eight percent of households had appropriate salt storage. Quantitative assays of household salt samples showed that median iodine content was 30 ppm. Iodine levels < 20, 20–40, and > 40 ppm were observed in 17, 63, and 20% of household salts, respectively. Figure 2 depicts the distribution of salt iodine content at different levels in this study.

Discussion

The prevalence of goiter has decreased gradually over the last 25 years in Iran. According to our previous national study (29), weighted TGR was 5.7% and all subjects had low grade goiter, and median urinary iodine concentration (UIC) was over 100µg/dl, indicating that the subjects had adequate iodine intake. The present national survey which was conducted in 2013–2014, indicated sustainable elimination of IDDs and favorable urinary iodine values in school-aged children of 30 provinces of Iran (Table 1). Since clinical evaluation of low-grade goiter has less validity, in this study urinary iodine rather than goiter prevalence was used as the principal indicator of iodine status.

Median urinary iodine concentration of schoolchildren in the current survey was 161µg/L. This value was 205µg/L in 1996, 165µg/L in 2001 and 140 µg/L in 2007 (Table 2). In 1996, two years after mandatory salt iodization in Iran, the median UIC values of schoolchildren were higher than the WHO/ UNICEF/ICCIDD optimal levels in many provinces of the country and in 2001, after 7 years of national salt iodization, despite any change in salt iodine content, the median UIC of Iranian schoolchildren was optimal. The decline in median UIC

values from 1996 to 2013 in our study may have been due to changes of dietary habits, particularly in younger people or some other environmental factors. Iodized oil injection during earlier years of salt iodization may also have played key role in above optimal levels of median UIC of schoolchildren in 1996. Such a downward trend was also observed between National Health and Nutrition Examination Surveys 1 and 3 in the United States; however it finally stabilized at adequate UIC levels in the next survey (30). This change is particularly important during pregnancy and lactation when low iodine intakes could be accompanied by adverse outcomes in vulnerable populations such as neonates, infants, and young children (31).

Since 1996, the mean (±SD) and median salt iodine at the production level have not changed significantly, as current values are 28.2 (± 12.6) and 31.7 ppm, respectively, while corresponding values in 1996 for 278 factory salt samples were 33.8 (± 13.2) and 33.9 ppm, in 2001 for 297 samples were 33.2 (± 13.4) and 32.8 ppm, and for 280 samples in 2007 were 23.2 (± 13.8) and 34.7 ppm, respectively (32-34). In 2013, frequency distributions of factory salts with iodine contents of < 20, 20–40, and > 40ppm were 9 , 71 , and 20% of samples, whereas in 2007, 2001 and 1996 it was 12, 70, and 18%, 17.2, 54.5, and 28.3% and 15.8, 54.7, and 29.5%, respectively. The median iodine contents of household salt sample was 30 ppm in 2013 and 2007 and 32.8 ppm in both 2001 and 1996. The frequency distributions of household table salts showed no significant differences during last four periods. Iodine content of < 20, 20–40, and > 40 ppm were 27, 53, and 20% in 2007; 8.3, 71.7, and 20.0% in 2001 and 7.8, 71.9, and 20.3% in 1996, respectively.

Iodine deficient soil is the major cause of iodine deficiency. Lapses in the monitoring programs and inadequate iodine supplies to the population at risk are the main factors for recurrence of iodine deficiency in a community. Evidence shows IDD relapse in some countries that had previously been successful in controlling IDD; in several countries with

well controlled IDD by USI, control programs faltered, and IDD recurred (35–40). In some industrialized countries such as Australia and New Zealand, previously thought to be iodine sufficient, IDDs have also relapsed (37, 38). A study by Zimmermann et al., in an area of endemic goiter in Morocco, showed that changes in thyroid function have occurred after sudden interruption of USI (39). A survey by Vanderpump indicates that the U.K. population is iodine deficient. In this study, 69% of 810 British girls, aged 14–15 years hade median UIC< 100 µg/L; which is consistent with iodine deficiency according to WHO standards. In addition, 18% had UIC levels below 50 µg/L (40). These data indicate that IDD control programs are fragile, and depend on a strong, long-term commitment from governments, donors, consumers, and the salt industry and monitoring of the indicators is a vital element of an effective and sustained program for the control and elimination of iodine deficiency disorders. (41).

In conclusion, the well-monitored salt iodization program in Iran has ultimately resulted in optimization of UIC, and drastically decreased the goiter rate 18 years after USI, although the later effect appeared some years after normalization of UIC. The median urinary iodine of schoolchildren was as similar to adequate levels as those reported in 1996, 2001 and 2007, indicating a well-established sustainable IDD program in Iran. An effective national office (IDD National Committee) has been active since 1989. The ministry of industries made it mandatory for salt factories to produce only iodized salt for household use. Public education and social mobilization on the importance of IDD and the consumption of iodized salt has been vigorously maintained over the last 25 years. The program has been integrated into the health network. Complete data on salt iodine at factory (daily), retail (monthly) and household levels and laboratory data on urine iodine in school aged children (yearly) and also at a national level every 5 yr, are collected in each province and analyzed by the IDD executive office. According to these criteria, the IR of Iran has achieved and maintained a

sustainable IDD control program since 1996. We conclude that the implementation of a sustainable and well- monitored IDD control program needs many effective programmatic steps, in particular its integration into the health network; furthermore, it may also require mandatory iodized salt consumption in certain situations.

For a sustainable and well- monitored IDD control program, prompt attention of the authorities of the Ministry of Health, salt producers, and other officials responsible for promotion, implementation, and monitoring of the National Iranian Program for Elimination of IDD and, periodical monitoring of any IDD control program following elimination of IDD are essential.

Table 1: Median urinary iodine content (UIC) among schoolchildren of 30 provinces of Iran (n=18000) aged 8–10 years

	Girls	Boys	Total
Urban	163*	161	164
Rural	153	163	158
Total	158	162	161

*µg/L

Table 2: Changes in median urinary iodine (MUI) and total goiter rate (TGR) in school-aged children between 1989 and 2013

Year	MUI (µg/L)	TGR (%)
1989	12–82	68.0
1996	205	54.0
2001	165	9.8
2007	145	5.7
2013	161	not done

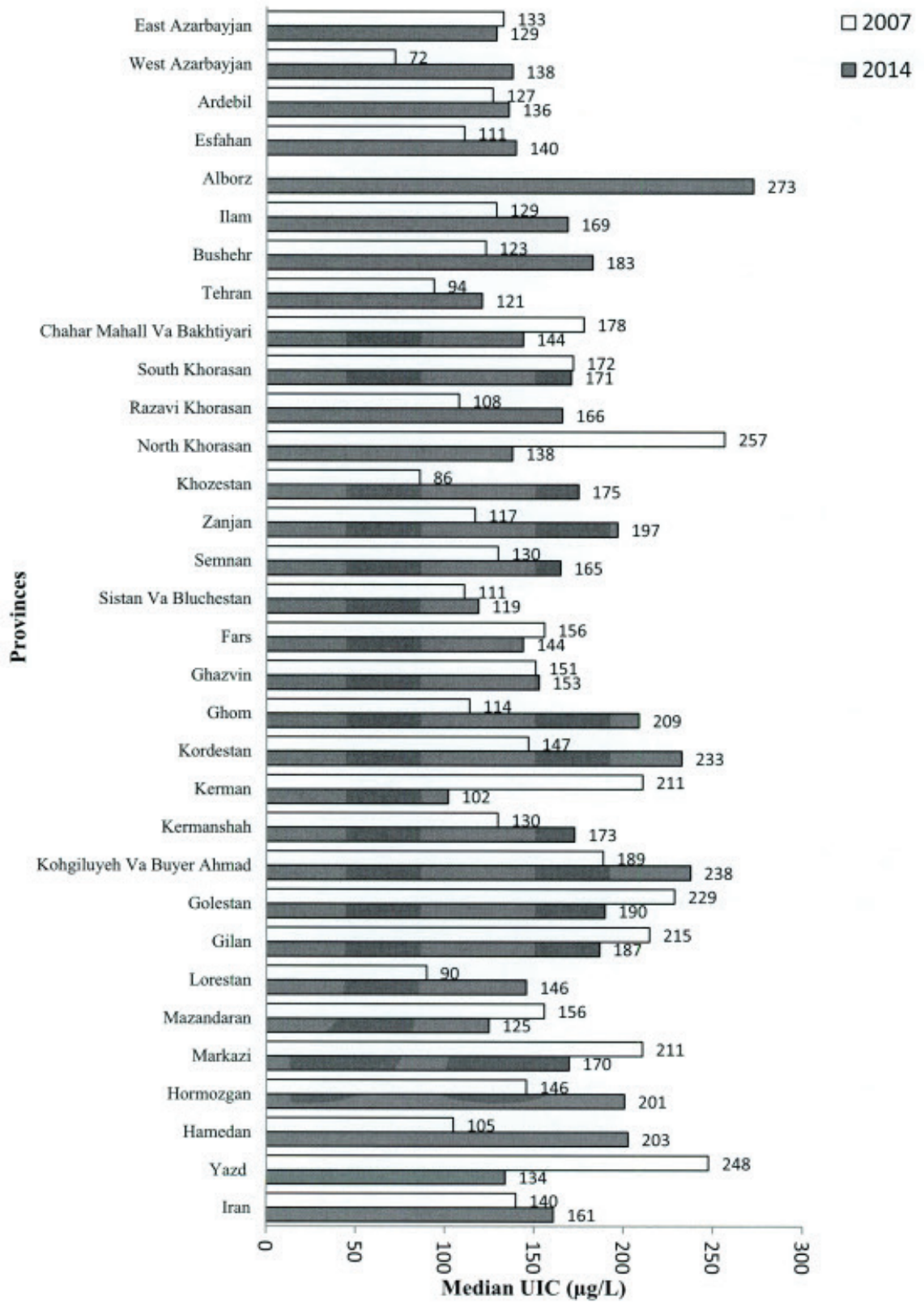

Fig.1: Comparison of median UICs in all provinces of Iran in 2007 and 2014

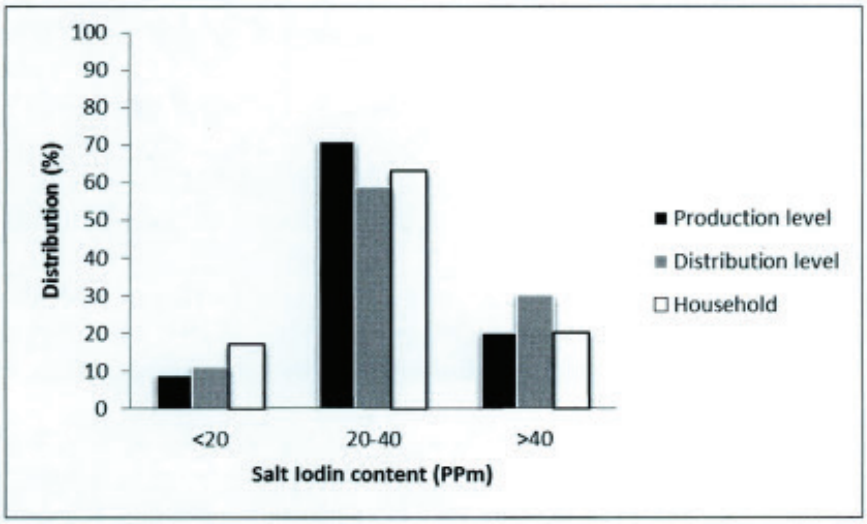

Fig. 2: Distribution (%) of salt iodine content (ppm) at production, distribution, and household levels, ppm, parts per million.

References

1- Zimmerman MB. Iodine deficiency. Endocr Rev 2009; 30:376–408.
2- Bleichrodt N & Born MP. A meta-analysis of research on iodine and its relationship to cognitive development. In The Damaged Brain of Iodine Deficiency, 1994; pp. 195–200
3- Salarkia N, Mirmiran P, Azizi F. Timing of the Effect of Iodine Supplementation on Intelligence Quotients of Schoolchildren. Int J Endocrinol Metab 2004; 2:95-102.
4- Hetzel BS. Progress in the prevention and control of iodine-deficiency disorders. Lancet 1987;.2:266.
5- De Benoist B, McLean E, Andersson M, Rogers L. Iodine deficiency in 2007: global progress since 2003. Food Nutr Bull.2008;.29:195–202.
6- Andersson M, Takkouche B, Ines Egli I. Current global iodine status and progress over the last decade towards the elimination of iodine deficiency. Bull World Health Organ 2005;.83:518–525.
7- World Health Organization. Elimination of Iodine Deficiency Disorders in South-East Asia. Report of an Expert Consultative Meeting. WHO, Thailand, 2007
8- Dunn JT. What's happening to our iodine? J Clin Endocrinol Metab 1998;.83:3398–3400.
9- Delange F, de Benoist B, Pretell E, Dunn JT. Iodine deficiency in the world: where do we stand at the turn of the century? Thyroid 2001;.11:437–447.
10- Vitti P, Delange F, Pinchera A, Zimmermann M, Dunn JT. Europe is iodine deficient. Lancet 2003;.361:1226.
11- . De Benoist B, Andersson M, Takkouche B, Egli I. Prevalence of iodine deficiency worldwide. Lancet 2003; 362: 1859–1860.
12- UNICEF. Sustainable Elimination of Iodine Deficiency. UNICEF, New York, 2008
13- Zimmermann MB , Andersson M. Update on iodine status world wide. Curr Opin Endocrinol Diabetes Obes. 2012; 19(5):382-7.
14- Zimmermann MB. Iodine deficiency and excess in children: worldwide status in 2013. Endocr Pract. 2013; 19(5):839-46.
15- Pearce EN , Andersson M, Zimmermann MB. Global iodine nutrition: Where do we stand in 2013? Thyroid. 2013; 23 (5): 523-8.
16- Azizi F, Sarshar A, Nafarabadi M, Ghazi A, Kimiagar M, Noohi S, Rahbar N, Bahrami A, Kalantri. Impairment of neuromotor and cognitive development in iodine deficient schoolchildren with normal physical growth. Acta Endocrinol (Copenh) 1993;129:501–504.
17- Azizi F, Kalani H, Kimiagar M, Ghazi A, Sarshar A, Nafarabadi M, Rahbar N, Noohi S, Mohajer M, Yassai M. Physical, neuromotor and intellectual impairment of noncretinous schoolchildren with iodine deficiency. Int J Vitam Nutr Res1995; 65:199–205.
18- Emami A, Shahbazi H, Sabzevari M, Gawam Z, Sarkissian N, Hamedi P. Goiter in Iran. Am J Clin Nutr 1969; 22:1584–1588.
19- World Health Organization. Regional Meeting for the Promotion of Iodized Salt in the Eastern Mediterranean, Middle East and North Africa: Report of an Inter-Country Meeting. WHO, Dubai, United Arab Emirates, 2000.
20- WHO/UNICEF/ICCIDD. Indicators for Assessing Iodine Deficiency Disorders and Their Control Through Salt Iodization. WHO, Geneva, 1994.

21- Azizi F. Salt Iodization, Monitoring, and Evaluation (SIME): an Effective Replacement for Universal Salt Iodization (USI). Int J Endocrinol Metab 2003; 2, 46-47.
22- Dunn JT. Complacency: the most dangerous enemy in the war against iodine deficiency. Thyroid 2000; 10:681–683.
23- Lwanga SK & Lemeshow S. Sample Size Determination in Health Studies. Geneva: WHO, 1990.
24- Narasinga Rao BS, Ranganathan S. A simple field kit for testing iodine in salt. Food Nutr Bull 1985; 7:70–72.
25- Sandell EB, Koltoff IM. Micro determination of iodine by a catalytic method. Michrochem Acta 1937; 1:9–25.
26- Dunn JT, Crutchfeld HE, Gutekunst R, Dunn AD. Methods for Measuring Iodine in Urine. Wagenigen: ICCIDD, UNICEF, WHO (OMS), The Netherlands, 1993.
27- WHO/UNICEF/ICCIDD. Indicators for Assessing Iodine Deficiency Disorders and Their Control Through Salt Iodization. WHO, Geneva, 1994.
28- Sullivan KM, Robin H, Gorstein J, Cervinskas J. Monitoring Universal Salt Iodisation Programs. UNICEF/ PAMM/MI/ICCIDD/WHO, Atlanta, GA, 1995.
29- Hossien Delshad, Atieh Amouzegar, Parvin Mirmiran, Ladan Mehran and Fereidoun Azizi. Eighteen Years of Continuously Sustained Elimination of Iodine Deficiency in the Islamic Republic of Iran: The Vitality of Periodic Monitoring. Thyroid 2012; 22:415-421
30- Caldwell KL, Jones R, Hollowell JG. Urinary iodine concentration: United States National Health and Nutrition Examination Survey 2005; 2001–2002. Thyroid 15:692–699.
31- Stanbury JB editor . The Damaged Brain of Iodine Deficiency. New York: Cognizant Communication. 1994.
32- Azizi F, Kimiagar M, Nafarabadi M, Yassai M. Current status of iodine deficiency in the Islamic Republic of Iran. EMR Health Serv J. 1990; 8:23–27.
33- Azizi F, Sheikholeslam R, Hedayati M, Mirmiran P, Malekafzali H, Kimiagar M, Pajouhi M. Sustainable control of iodine deficiency in Iran: beneficial results of the implementation of the mandatory law on salt iodization. J Endocrinol Invest 2002; 25:409–413.
34- Azizi F, Mehran L, Sheikholeslam R, Ordookhani A, Naghavi M, Hedayati M. Sustainability of a well-monitored salt iodization program in Iran: marked reduction in goiter prevalence and eventual normalization of urinary iodine concentrations without alteration in iodine content of salt. J Endocrinol Invest 2008; 31:422–431.
35- Current IDD Status Database. International Council for the Control of Iodine Deficiency Disorders Website. Available at www.iccidd.org (accessed August 12, 2003).
36- Markou KB, Georgopoulos NA, Makri M, Anastasiou E, Vlasopoulou B, Lazarou N, Veizis A, Sakellaropoulos G, Vagenakis AG. Iodine deficiency in Azerbaijan after the discontinuation of an iodine prophylaxis program: reassessment of iodine intake and goiter prevalence in schoolchildren. Thyroid 2001; 11:1141–1146.
37- Li M, Ma G, Boyages SC, Eastman CJ. Re-emergence of iodine deficiency in Australia. Asia Pac J ClinNutr 2001; 10:200–203.
38- Thomson CD, Woodruffe S, Colls AJ, Joseph J, Doyle TC. Urinary iodine and thyroid status of New Zealand residents. Eur J Clin Nutr 2001; 55:387–392.
39- Zimmermann M, Wegmuller R, Zeder C, Torresani T, Chaouki N. Rapid relapse of thyroid dysfunction and goiter in school-age children after discontinuation of salt iodization. Am J Clin Nutr 2004; 79:642–645.

40- Vanderpump M. UK population is iodine deficient. Presented at Society for Endocrinology BES 2011, Birmingham, United Kingdom, April 11–14, 2011.
41- WHO/UNICEF/ICCIDD. Assessment of Iodine Deficiency Disorders and Monitoring Their Elimination, 2nd edition. WHO, Geneva, 2001.

مقاله اولین پایش ملی دریافت ید زنان باردار کشور

Inadequate iodine nutrition of pregnant women in an area of iodine sufficiency

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Abstract:

Purpose: I.R.Iran has been considered iodine replete since 2000, but iodine nutrition of vulnerable subjects is not clear. The main goal of this study was assessment of iodine nutrition and thyroid function in pregnant Iranian women.

Methods: A total of 1072 pregnant women from ten provinces in the different parts of the country, were recruited from November to March 2014. Median urinary iodine concentration (UIC) as the measure of iodine status and serum free T4 (FT4), thyrotropin (TSH), thyroglobulin (Tg), anti-thyroglobulin and anti-thyroidperoxidasre antibodies (TgAb and TPOAb) were measured.

Results: Mean ±SD age of the cohort was 27.0 ± 7.2 years and gestational age was 20.7 ± 10.0 weeks. The median UIC for pregnant women was 87.3µg/L, being 92.1, 86.0 and 76.8 µg/L, in three trimesters of pregnancy, respectively. Median UIC of <100, 100–149, 150-249, 250-499 and ≥500 µg/L was found in 58.4, 19.8, 16.2, 5.13 and 0.46% of subjects, respectively. Median (IQR) values in the first, second, and third trimesters were 1.7(0.9 –

2.8), 2.1 (1.5 – 2.9), and 2.1 (1.4 – 2.8) mIU/L for TSH, and 16.4 (12.21-21.13), 14.34 (12.16-19.69), and 14/07(12.02-18.64) pmol/L for FT4, respectively. The frequency of elevated serum TSH was 9.0% (6.6% subclinical, 2.4% overt hypothyroidism). The frequency of low serum TSH was 0.6%. The frequency of positive TPOAb was 7.6 %.

Conclusions: Results of this study, has clarified that despite iodine sufficiency of school children in Iran, pregnant women have moderate iodine deficiency and need iodine supplementation.

Key words: Iodine, Pregnancy, Iodine deficiency, UIC, Thyroid function

Introduction

Iodine is the major component of thyroid hormones which are vital for neurocognitive development of the fetus and newborn (1, 2). Inadequate levels of thyroid hormones during pregnancy may contribute to obstetric complications for the mother and the fetus (3). Pregnant women are vulnerable to iodine deficiency as the effects of in utero deficiency on the developing fetus may have life-long consequences for the offspring. Severe iodine deficiency during pregnancy is well-known to cause cretinism and severe mental retardation (4- 7). Bath SC et al have recently found mild-to-moderate iodine deficiency in a large UK cohort of pregnant women and the children of those that had low iodine status in early pregnancy were more likely to have significantly lower IQ and reading scores(8).

The fundamental changes in thyroid function during normal pregnancy and lactation include increased thyroid hormone production, increased renal iodine excretion and iodine secretion into breast milk, and iodine requirement for the fetus (9). Therefore, a woman needs more iodine during pregnancy and lactation to maintain normal metabolism as well as for the transfer of thyroxine and iodine to the fetus and neonate. Though it is vital that pregnant women meet their iodine requirements, this is not always achieved even in developed countries such as the USA (10). Ideally, women should have adequate intra-thyroidal iodine

stores before conception, which should be ensured by universal salt iodization (UIC) programs, but the American Thyroid Association (ATA) has recommended 150µg iodine daily as dietary supplement for all pregnant women (11). The most recent recommendation has been endorsed by World Health Organization (WHO) (12), UNICEF (13) and Iodine Global Network (IGN) formerly ICCIDD (14). According to recent guidelines of both the ATA (15), and the Endocrine Society (16), daily intake of 250 µg iodine has been advised for all pregnant and breastfeeding women, not only in iodine-deficient areas, but also in iodine-sufficient regions.

Iodine deficiency has been aggressively addressed in I.R. Iran by the production and consumption of iodized salt since 1970 and three national surveys have shown iodized salt consumption by > 95% of the population and an adequate UIC of 232, 190, and 140 µg/L among schoolchildren in 1996, 2001, and 2006, respectively (17-19). In our latest national survey in 2014, the median UIC of 18,000 schoolchildren was 161µg/L, which indicates sustainability of iodine sufficiency in I.R. Iran (unpublished data). However, pregnant as well as lactating women and their newborns (up to early infancy) are among the populations the most vulnerable to the detrimental effects of iodine deficiency. Therefore, the aim of this study was to assess iodine intake and the prevalence of thyroid dysfunction in a national representative sample of pregnant women in Iran.

Material and methods

Study population

This is an observational, cross-sectional study. A total of 1200 pregnant women attending antenatal care clinics in the mother and child health care centers in 10 provinces, randomly selected from 31 provinces of the country, included women aged 20-40 years who had lived in the city for more than 5 years with pre-gestational regular menses and were pregnant with a singleton pregnancy and in the first, second and third trimester of their pregnancy (400

pregnant women in each trimester) were consecutively recruited from November to March 2014. Excluded were smokers and those women with a history of thyroid disease or any other chronic diseases, and subjects on any medical regimen before pregnancy that may affect thyroid function, such as glucocorticoids, dopamine, or antiepileptic drugs. All women were asked to complete the study questionnaire at their first visit and written informed consent was obtained. The study was approved by the human research committee of the Research Institute for Endocrine Sciences. Of these 1200 women, 128 subjects were excluded, because of inadequate urine samples for measurement of urinary iodine concentration, and finally 338, 389 and 295 pregnant women recruited at the first, second and third trimester, respectively.

Procedures

Trained midwives explained the rationale of the study to the pregnant women and collected demographic data (including age, parity and gestational age) and medical history (including thyroid medications and history of previous thyroid disorders). Gestational age was calculated from the first day of the last normal menstrual period and gestational ages <12, 12-23.9, and >24 weeks comprised the first, second, and third trimesters of pregnancy.

Laboratory measurements

Urinary iodine concentration (UIC) was measured in random urine samples using a manual method based on the Sandell-Kolthoff technique (20) and the results were expressed as microgram of iodine per liter of urine (µg/L). The urine samples were not dipsticked for other assays. The analytical sensitivity for iodine was 1.39 µg/L and the intra-assay and inter-assay coefficients of variation were 4.4 and 3.9%, respectively.

Venous blood samples were collected from pregnant women, using anticoagulant-free tubes and after centrifugation the serum samples were stored at -80° C until analyses. Serum FT4,TSH, and thyroglobulin (Tg) were measured by the electrochemiluminescence immunoassay (ECLIA) method, using Roche Diagnostics kits and the Roche/Hitachi Cobas

e-411 analyzer (GmbH, Mannheim, Germany). Anti-thyroid peroxidase (TPOAb) and anti-thyroglobulin (TgAb) antibodies were determined by immunoenzymometric assay (IEMA) using commercial kit (Monobind, Costa Mesa, CA, USA). All tests performing by enzyme-linked immunosorbent assays were done by a Sunrise ELISA reader (Tecan Co. Salzburg, Austria). Lyophilized quality control material (Lyphochek Immunoassay Plus Control, Bio-Rad Laboratories, Irvine, CA, USA) in three different concentrations were used to check accuracy of assays; also a pooled serum was prepared, aliquoted and stored at −80° and assayed in all runs for monitoring precision of measurements. The intra assay coefficients of variation (CV) of serum FT4,TSH, TPOAb, TgAb, and Tg were 1.49-4.18%, 2.1 -3.3% , 2.40-6.1%, 1.3- 4.7% and 1.9- 5.0%, respectively. The interassay CV values for above mentioned parameters were 4.65-7.99%, 1.30-7.85%, 2.2- 6.7%, and 3.8-5.8%, respectively.

Definitions and diagnostic criterion for thyroid disorders

We applied our local trimester specific reference ranges of TSH and FT4 made by our laboratory based on Guideline 22 of the National Academy of Clinical Biochemistry (21) A total of 466 Iranian pregnant women, who had the same ethnicity of Persians, in the first trimester of pregnancy attending antenatal care clinics in the mother and child health care centers of two general hospitals of Tehran were consecutively recruited from November 2004 to November 2006. Only women with singleton pregnancies were enrolled. Inclusion criteria required documentation that thyroid-related measurements were available in all of the three trimesters. Of 466 women who were referred in the first trimester, 147 subjects were excluded because of preexisting thyroid disorders or nodules; those taking medications affecting thyroid function and those not available in all trimesters or lost to follow-up (referring elsewhere for delivery, nonviable pregnancy) were excluded, and 219 healthy pregnant women were selected. A further 20 subjects were excluded due to laboratory results of positive serum thyroid peroxidase antibodies (TPOAb > 40 IU/mL), low urinary iodine

level (<150 μg/dL in two out of 3 sample measurements in the first trimester) (34 subjects), and enlarged thyroid gland (thyroid volume greater than 30 mL) by ultrasonography (9 subjects). None had overt hypo- (TSH > 4.5 mIU/L and T4 < 5.5) or hyperthyroidism (TSH < 0.1 mIU/L & T4 > 14.5) or subclinical hypothyroidism (TSH > 10 mIU/L). Those with subclinical hyperthyroidism (serum TSH levels under 0.1 mIU/L and normal T4) were not excluded due to normal TSH suppression at pregnancy. Finally 152 healthy iodine sufficient women with viable, singleton pregnancies comprised the cohort study. Reference intervals in the first, second, and third trimesters were as follows: TSH 0.2–3.9, 0.5–4.1, and 0.6–4.1 mIU/l, respectively (22). Subclinical hypothyroidism was defined as TSH between 3.9 and 10mIU/L in the first and between 4.1 and 10 mIU/L in both the second and third trimester, with normal FT4 in all trimesters of pregnancy. Overt hypothyroidism was defined as TSH> 10 mIU/L or TSH> 3.9 mIU/L and FT4 < 12.5 pmol/L in the first, TSH > 4.1 mIU/L and FT4< 12.8 pmol/L in the second, and TSH> 4.1mIU/L and FT4< 12.0 pmol/L in the third trimesters of pregnancy. The reference of TPOAb 0-35 IU/ml, and TgAb 0-115 IU/ml were provided by the manufacturer. According to UIC values, pregnant women were divided into five groups: UIC< 100 µg/L, UIC 100-149 µg/L, UIC 150-249 µg/L, UIC 250-499 µg/L, and UIC≥ 500 µg /L, but for defining nutritional status, they stratified in tow groups with UIC< 150 and UIC ≥ 150 µg /L.

Statistical analysis

The Kolmogorv-Smirnov method was used to test data distribution normality. Normally distributed values are reported as mean ± SD, or if not so, were reported as median and interquartile range (IQR). Repeated measure test was used to compare FT4between 3 trimesters and the Friedman test was used for TSH comparison. McNemar test was applied for comparison of prevalence of hypothyroidism based on 2 different cut points of TSH; P-values< 0.05 denoted statistical significance. One-way ANOVA with post hoc Scheffe

correction was used to test differences of serum Tg between groups of participants. Linear regression was used between UIC and thyroid function parameters. Mann-Whitney test was used to compare differences in continuous variables between trimesters. The statistical soft ware SPSS version 20 was used for data analysis.

Results

A total of 1072 participants were recruited in this study. Table 1 shows demographic and biochemical parameters in participating women.

Urinary iodine concentration (UIC)

In total cohorts, the median (IQR) of UIC was 87.3(46.5-139.1) µg/L, it was 92.1(48.8-145.5), 86.0(46.2-137.5), and 76.8 (42.8-132.8) µg/L in the first, second, and third trimesters, respectively. 838(78.2%) of women had UIC < 150 µg/L and 234 (21.8) had UIC < 150 µg/L. According to WHO criteria, 19.8% of all pregnant women had mild (UIC=100 – 150 µg/L) and 58.4% had moderate (UIC=50 – 100 µg/L) iodine deficiency. Table 2 shows the percent of frequency distribution of median UIC by trimester of pregnancy. The mean, median, 10^{th} and 90^{th} percentiles of UIC in the study population are depicted in table 3.

Thyroid tests results

The median (IQR) of serum TSH concentration was 1.70(0.90-2.80), 2.10(1.50-2.90) and 2.10(1.40-2.80) mIU/L in the first, second, and third trimester, respectively ($p<0.001$). The median (IQR) of FT4 was 16.40 (12.21-21.13), 14.34 (12.16-19.69), and 14.07 (12.02-18.64) pmol/L in the first, second and third trimester, respectively (NS). TPOAb was positive in 82 subjects (7.6%) of whom 44(4.0%), 24(2.3%), and 14(1.3%) subjects who were in their first, second, and third trimesters, respectively. Table 4 depicts serum concentrations of TSH, FT4, Tg and positive TPOAb in different UIC groups.

Prevalence of thyroid dysfunction

Considering our local trimester specific reference range for TSH (0.2 – 3.9 mIU/L in the first and 0.3 – 4.1 mIU/L in the second and third trimesters) 0.6 % (7 subjects) had low TSH and the frequency of elevated serum TSH was 9.0% (96 subjects). 97.9% of subjects with elevated TSH had subclinical hypothyroidism, but when the ATA recommended trimester specific reference ranges were used, 33.9% (359 subjects) had TSH > 2.5 mIU/L in the first, while 10.6% (114 subjects) had TSH>3.0 mIU/L in the second and third trimesters (Fig.1). In total cohorts there was significant difference in the prevalence of subclinical hypothyroidism based on 2 different cut points (p=0.001). Overt hypothyroidism was detected in 6, 5, and 7 women in the first, second and third trimesters of pregnancy. No body had isolated hypothyroxinemia. In the total population, the frequency of positive TPOAb was 7.6 %. Median serum Tg was not significantly different in women with UIC ≥ 150 µg/L and those with UIC< 150 µg/L. Table 5 depicts prevalence of thyroid disorders in different UIC groups.

Discussion

The median UIC of subjects in this study indicates moderate iodine deficiency among pregnant women in Iran, a country considered as iodine sufficient based on school-aged children UIC for one decade. The overall prevalence of thyroid dysfunction in pregnant women in this study was 9.6%. Mean FT4 was not significantly different in three trimesters of pregnancy (P=0.20). TPOAb was positive in 7.6 % of women and nobody had increased in Tg levels. There are currently no validated thresholds for serum Tg values in pregnancy with regard to identifying population iodine status.

Inadequate levels of thyroid hormone during pregnancy may contribute to obstetric complications for the mother and neurodevelopmental deficits in the fetus (4, 5). This topic received increased attention during last few decades and in 2012, the Endocrine Society guideline recommended: "As long as possible before pregnancy and during pregnancy and breastfeeding, women should increase their daily iodine intake to 250 µg on average by daily

oral iodine supplement of 150-200 µg/d irrespective of historical iodine nutrition status" (16). As a component of thyroid hormones, iodine is essential for regulation of metabolic processes in most cells, besides playing a vital role in the development of most organs, in particular the brain for adequate thyroid hormone synthesis throughout life, therefore assuring adequate iodine nutrition, especially during pregnancy is essential. Many physicians who encounter pregnant women do not have sufficient information about management of thyroid disorders and providing iodine support during pregnancy and lactation (23). There are a few well conducted studies on iodine nutrition in pregnancy, based on median UIC (24- 28). Different studies have shown that median UIC in children cannot be used to define normal iodine nutrition in pregnancy and it is suggested that even in an iodine-sufficient area, an additional iodine supply might be necessary during pregnancy and lactation. The Yozen Fuse et al study (29) in Japan, which is regarded as an iodine-sufficient or even excessive country, a substantial percentage of pregnant and lactating women had UICs below100 µg/L and could be at risk for iodine deficiency if there is a restriction of iodine-rich foods. In the present study conducted in an area with iodine sufficiency, it was shown that despite a legislated national program of iodization of all household salts and the consumption of iodized salt by more than 95% of the population, with sustained adequate median UIC among schoolchildren in all provinces of Iran during the years after national salt iodization, the median UIC of pregnant women was 87.3 µg/L, indicating moderate iodine deficiency. Only 21.8% of subjects had UIC > 150 µg/L. In our previous study we found variations of urinary iodine concentration (UIC) during a 4-week period among pregnant and non-pregnant women in Tehran, capital city of Iran. There was a wide intrapersonal variation in UIC values among pregnant and non-pregnant women residing in an iodine-replete area, supporting the notion that causal UIC would not reflect the iodine status of the individual (30). Similar findings have been demonstrated in Ireland (31), Switzerland (32), Tasmania (Australia) (33), and

Japan (34),whereas studies from Spain (35), France (36), and Hong Kong (37) have shown that with the progression of pregnancy, the median UIC was increased, however, a statistically significant change was observed only in Hong Kong study.

Based on trimester specific reference ranges of thyroid parameters derived from our local study, the overall prevalence of thyroid dysfunction in Iranian pregnant women in present study was 9.5%. According to recently published guidelines (15,16) which recommend normal TSH value less than 2.5 mIU/L in the first trimester and 3.0 mIU/L in the second and third trimesters, in our study 395 subjects (66.8%) had elevated TSH which was significantly higher than those using our local reference range ($p<0.001$) (Fig.1). In the present study, the frequency of positive TPOAb was 7.6%. Pregnant women diagnosed with thyroid autoimmunity early in pregnancy should be monitored for further changes in serum TSH during the subsequent trimesters, since these women are considered to be at higher risks of early miscarriage and also of developing hypothyroidism later. There is no universal consensus regarding to prescribe levothyroxine in euthyroid women with autoimmune thyroid disease, but a few studies have addressed this issue (38).

In this study we have found mild to moderate iodine deficiency among a pregnant population by measuring UIC, yet this deficiency was not reflected by other indicators (FT4 and TSH), supporting the notion that thyroid function is not considered to be a valid marker for mild to moderate iodine deficiency in adult. Study by Moleti M and his co-worker has shown that the neuro-intellectual outcomes in children appear to be more dependent on their mothers' nutritional iodine status than on maternal thyroid function. These results support the growing body of evidence that prenatal, mild-to-moderate iodine deficiency adversely affects cognitive development later in life, with a seemingly greater impact on verbal abilities (39).

The causal UIC reflects iodine intake over a short time period and the variation is huge, which affects the reliability of studies of iodine nutrition and UIC should not be used for the purpose of individual diagnosis and treatment. Also, some studies have confirmed that if the spot urine samples are randomly collected from a sufficient number of individuals, the median UIC obtained would be a reliable indicator of iodine status of that population and there would be no need for cumbersome and less feasible methods of measurement of iodine and/or creatinine in 24 hour urine samples. The number of spot urine samples required to estimate iodine status in a population with a 95% confidence interval within precision range of 10% and 5% should be approximately 125 and 500, respectively (40). A study by Antonin Korenek et al of 168 pregnant women of the Czeck republic shows that although all participants had sufficient UIC measured as the amount of iodine in urine over 24 hours during the first trimester of pregnancy, 14 subjects had elevated TSH levels signaling subclinical or incipiently clinical hypothyroidism (41). A similar study by Raverot V et al from Lyon has shown that healthy pregnant French women are iodine deficient, and overall 11% of them had abnormal TSH or positive TPOAb (42). These data raise the question of what is the most appropriate indicator for assessing iodine status during pregnancy, maternal free T4 during pregnancy is an important risk factor for impaired psychomotor development in infants and in an individual pregnant women, the best surrogate for measuring iodine sufficiency is maternal thyroid function. It seems that TSH and freeT4 may be better indicators for iodine deficiency in the first trimester, but this would require the development of method-specific and trimester specific reference intervals for free T4 estimates in pregnancy. On the other hand most experts would disagree with this concept.

Our study highlights the need for ongoing surveillance of the iodine status in various communities and support the call to raise awareness of the need for pregnant women to increase their iodine intake. Many controlled iodine supplementation trials in pregnancy

have been conducted in different countries which have shown no adverse effects of 50-300 µg daily iodine supplementation in moderately iodine deficient women. These studies suggest that in areas of mild-to-moderate iodine deficiency, the maternal thyroid is able to adapt to meet the increased thyroid hormone requirements of pregnancy. Whether or not mild-to-moderate maternal iodine deficiency produces more subtle changes in cognitive and/or neurologic function in the offspring is uncertain. Mild maternal iodine deficiency may be associated with low child IQ even in the absence of TSH elevations or low FT4 (8). Other studies using different measures of impaired maternal thyroid function also have reported developmental impairment in the offspring of affected mothers, even if maternal hypothyroidism is mild and asymptomatic (8,43). In a meta-analysis of 37 studies (n=12,292 children), it was shown that the children of mothers supplemented by oral iodine either before or during pregnancy had higher scores of Intelligence Quotient (IQ) compared to children whose mothers were living in severely iodine-deficient areas (44). The most recent NHANES survey (2005-2008) conducted in the USA indicated that 35.3% of pregnant women had UIC less than 100µg/L (45). Regarding concerns about mild iodine deficiency in at least some pregnant women, the ATA recommends that all women need 150-200 µg iodine daily as dietary supplements during pregnancy and lactation (11). WHO has also advocated daily iodine supplementation or annual iodized oil supplements for pregnant women in region where only less than 30% of households use iodized salt. In Iran, the main source of iodine supply is iodized salt for household use and it is mandated to be fortified in the country. As the universal salt iodization may not be adequate during pregnancy, we strongly recommend supplementation of 150 µg of iodine during pregnancy, and if possible for months before conception.

Table 1: Demographic and biochemical parameters of thyroid function by trimester in 1072 pregnant Iranian women

Variable	1st trimester (n=388)	2nd trimester (n=389)	3rd trimester (n=295)	All (n=1072)
Age (yr) *	27.2 ± 6.9	26.8 ± 7.6	27.4± 6.8	27.1 ± 7.2
Gestational age (weeks) *	9.9 ± 2.4	21.4 ± 4.1	33.9 ± 2.6	20.7 ± 10.0
TSH (mIU/L)†	1.7 (0.9-2.8)	2.1 (1.5-2.9)	2.1 (1.4-2.8)	2.0 (1.3-2.8)
FT4 (pmol/l) †	16.4 (12.21-21.13)	14.34 (12.16-19.69)	14.07 (12.02-18.64)	15.92 (12.14-21-56)
Tg (µg/L)†	12.1 (5.6-20.3)	12.4 (5.2-20.9)	13.1 (6.9-24.8)	12.4 (5.9-21.7)
UIC (µg/L)†	92.1 (48.8-145.4)	86.0 (46.2-137.5)	76.8 (42.8-132.8)	87.3 (46.5-139.1)
TPOAb+ (%)†	44.0 (11.3)	24.0 (6.2)	14.0 (4.7)ŧ	82.0 (7.6)

† Values are given as Median (IQR)

*Values are given as mean± SD

ŧ P<0.004

Table 2 Percent of Frequency distribution of median UIC by trimester of pregnancy in study population

Trimester of Pregnancy	Urine iodine concentration(µg/L)				
	<100	100 – 149.9	150 – 249.9	250 – 499.9	≥500
First (n = 388)	201(32.20)*	94(44.34)	72 (41.40)	20 (36.40)	1 (20.0)
Second (n = 389)	245(39.10)	62(29.24)	57 (32.80)	23 (41.80)	2 (40.0)
Third (n = 295)	180(28.70)	56(26.42)	45 (25.90)	12 (21.80)	2 (40.0)
All (n = 1072)	626(58.40)	212(19.78)	174(16.23)	55(5.13)	5(0.46)

*Number of women (%)

Table 3. Mean, median, 10th and 90th percentiles of urinary iodine concentration (UIC) during the three trimester of pregnancy in the study population

UIC (µg/L)	1st trimester	2nd trimester	3rd trimester	All
Mean ± SD	110.6 ± 81.1	106.4 ± 86.9	100.1 ± 81.2*	106.2 ± 83.3
Median (IQR)	92.1 (48.8-145.5)	86.0 (46.2-137.5)	80.0 (45.0-136.0)	87.3 (46.5-139.1)
Range (Min-max)	15.0-636.0	17.0-703.0	17.0-666.0	15.0-703.0
10th percentile	30.2	29.0	32.0	28.8
90th percentile	301.7	311.6	299.5	313.5

*No significant difference between trimesters

Table 4: Median (IQR) of serum concentration of thyroid parameters in different UIC groups

UIC(µg/L)	n	TSH (mIU/L)	FT4(pmol/ l)	Tg (µg/L)
<100	626	1.9 (1.3-2.9)	15.9 (12.4-22.8)	12.9 (5.8-22.9)
100-149	212	1.8 (1.3-2.7)	16.7 (12.24-21.30)	11.1 (4.7-20.1)
150-250	174	2.1 (1.4-3.1)	15.20 (11.81-21.42)	11.7 (6.8-20.4)
250-500	55	1.9 (1.2-3.1)	14.59 (8.6-21.08)	13.2 (8.9-18.9)
≥500	5	2.1 (1.1-2.9)	15.06 (12.11-21.98)	9.8 (6.6-22.3)

REFERENCES

1- Delange F. The role of iodine in brain development. The Proceeding of the Nutrition Society. 2000; **59**:75-79.
2- Zimmermann MB. Iodine deficiency. *Endocr Rev*. 2009; **30**:376–408.
3- Krassas GE, Popoe K, Glinor D. Thyroid function and human reproductive health. *Endocrine Reviews*. 2010; **31**: 702-755.
4- de Escobar GM, Ares S, Berbel P, et al.. The changing role of maternal thyroid hormone in fetal brain development. *Semin Perinatol*.2008;**32**:380-386
5- Sarah C. Bath, Alan Walter, Andrew Taylor, et al. Iodine deficiency in pregnant women living in the South-East of the UK: the influence of diet and nutritional supplements on iodine status. *Br J Nutr*. 2014 ; 111(9): 1622–1631
6- Haddow JE, Palomaki GE, Allan WC, et al. Maternal thyroid deficiency during pregnancy and subsequent neuropsychological development of the child. *New England Journal of Medicine*. 1999; **341**:549–55.
7- Teng W, Shan Z, Patil-Sisodia K, Cooper DS. Hypothyroidism in pregnancy. *Lancet Diabetes Endocrinol*. 2013; **1**: 228-237.
8- Bath SC, Steer CD, Golding J, et al. Effect of inadequate iodine status in UK pregnant women on cognitive outcomes in their children: results from the Avon Longitudinal Study of Parents and Children (ALSPAC). *Lancet*. 2013; **382**:331–337
9- Smyth PPA. Variation in iodine handling during normal pregnancy. *Thyroid*, 1999; **9**: 637-642.
10- Caldwell K, Pan Y, Mortensen ME, et al. Iodine Status in Pregnant Women in the United States: National Children's Study and National Health and Nutrition Examination Survey. *Thyroid*. 2013 doi: 10.1089/thy.2013.0012.
11- Becker DV, Braverman LE, Delange F, et al. Iodine supplementation for pregnancy and lactation—United States and Canada: recommendations of the American Thyroid Association. *Thyroid,* 2006; **16**:949–951
12- WHO Secretariat, Andersson M, de Benoist B, Delange F, Zupan J. Prevention and control of iodine deficiency in pregnant and lactating women and in children less than 2-years-old: conclusions and recommendations of the Technical Consultation. *Public Health Nutrition*. 2007;**10**:1606–1611
13- WHO/UNICEF. Reaching optimal iodine nutrition in pregnant and lactating women and young children. Joint Statement by the WHO and the UNICEF. *World Health Organization, Geneva*. 2007
14- International Council for Control of Iodine Deficiency Disorders. Iodine requirements in pregnancy and infancy. *IDD Newsletter*. 2007; **23**(1): 1-2.
15- Stagnaro-Green, Abalovich M, Alexander E, et al. Guidelines of the American Thyroid Association for the diagnosis and management of thyroid disease during pregnancy and postpartum. *Thyroid*. 2012; **21**: 1081-1125.
16- De Groot L, Abalovich M, Alexander EK, et al. Management of thyroid dysfunction during pregnancy and postpartum: an Endocrine Society clinical practice guideline. *The Journal of Clinical Endocrinology and Metabolism*. 2012; **97**: 2543-2565.

17- Azizi F , Sheikholeslam R, Hedayati M, et al. Sustainable control of iodine deficiency in Iran: beneficial results of the implementation of the mandatory law on salt iodization. *Journal of Endocrinological Investigation*. 2002; **25**(5): 409-413.
18- Azizi F, Mehran L, Sheikholeslam R, et al. Sustainability of a well-monitord salt iodization program in Iran: marked reduction in goiter prevalence and eventual normalization of urinary iodine concentrations without alteration in iodine content of salt. *Journal of Endocrinological Investigation.* 2008; **32**(5): 422-431.
19- Delshad H, Amouzegar A, Mirmiran P, et al. Eighteen years of continuously sustained elimination of iodine deficiency in the Islamic Republic of Iran: the vitality of periodic monitoring. *Thyroid*. 2012; **22**:415-421.
20- Dunn JT, Crutchfield HE, Gutekunst R, Dunn AD. Methods for measuring iodine in urine. The Netherlands: *ICCIDD/UNICEF/WHO Publications*.1993.
21- Baloch Z, Carayon P, Conte-Devolx B, et al. Laboratory medicine practice guidelines. Laboratory support for the diagnosis and monitoring of thyroid disease. *Thyroid*. 2003; **13**:3-126.
22- Mehran L. Amouzegar A, Delshad H et al. Trimester-specific reference ranges for thyroid hormones in Iranian pregnant women. J Thyroid Res. 2013; 65: 15-17.
23- Kut A , Kalli H , Anil C , Mousa U , Gursoy A. Knowledge, attitudes and behaviors of physicians towards thyroid disorders and iodine requirements in pregnancy. J Endocrinol Invest. 2015; 38(10):1057-64.
24- Lise Brantsæter A, Hope Abel M, Haugen M, Meltzer HM. Risk of Suboptimal Iodine Intake in Pregnant Norwegian Women Nutrients. 2013 February; 5(2): 424–440.
25- K Michael Hambidge, Nancy F Krebs, Jamie E Westcott et al. Preconception maternal nutrition: a multi-site randomized controlled trial .BMC Pregnancy Childbirth.2014; 14: 111
26- Sarah C Bath, Victoria L, Furmidge-Owen, Christopher WG Redman, Margaret P Rayman. Gestational changes in iodine status in a cohort study of pregnant women from the United Kingdom: season as an effect modifier.Am J Clin Nutr. 2015; 101(6): 1180–1187
27- Sarah C. Bath, Alan Walter, Andrew Taylor et al. Iodine deficiency in pregnant women living in the South-East of the UK: the influence of diet and nutritional supplements on iodine status. Br J Nutr. 2014 May; 111(9): 1622–1631
28- M Kibirige, S Hutchison, C Owen, H Delves. Prevalence of maternal dietary iodine insufficiency in the north east of England: implications for the fetus. Arch Dis Child Fetal Neonatal Ed. 2004; 89(5):436– 439
29- Yozen F, Yoshimasa S, Minoru I. Gestational changes of thyroid function and urinary iodine in thyroid antibody-negative Japanese women. *Endocrine Journal.* 2013; **60**(9): 1095-1106.
30- Amouzegar A, Azizi F. Variations of urinary iodine during the first trimester of pregnancy in an iodine-replete area. Comparison with non-pregnant women. *Hormones.* 2013; **12**(1): 111-11

31- Smyth PPA, Hetherton AMT, Smith DF, et al. Maternal iodine status and thyroid volume during pregnancy: correlation with neonatal iodine intake. *The Journal of Clinical Endocrinology and Metabolism.*1997; **82**: 2840-2843

32- Brander L, Als C, Buess H, et al. Urinary iodine concentration during pregnancy in an area of unstable dietary iodine intake in Switzerland. *Journal of Endocrinological Investigation.* 2003; **26**: 389-396. .

33- Stilwell G , Reynolds PJ, Parameswaran V, et al. The influence of gestational stage on urinary iodine excretion in pregnancy. *The Journal of Clinical Endocrinology and Metabolism.* 2008; **93**:1737-1742.

34- Fuse Y , Ohashi T, Yamaguchi S, et al. Iodine status of pregnant and postpartum Japanese women: effect of iodine intake on maternal and neonatal thyroid function in an iodine-sufficient area. *The Journal of Clinical Endocrinology and Metabolism. 2011;* **96**: 3846-3854.

35- Alvarez-Pedrerol M, Guxens M, Mendez M, et al. Iodine levels and thyroid hormones in healthy pregnant women and birth weight of their offspring. *European Journal of Endocrinology*. 2009 ;**160**: 423-429

36- Luton D , Alberti C, Vuillard E, et al. Iodine deficiency in Northern Paris area: impact on fetal thyroid mensuration. *PLoS ONE.* 2011; **6**(2): e14707

37- Kung AWC, Lao TT, Chau MT, et al. Goitrogenesis during pregnancy and neonatal hypothyroxinaemia in a borderline iodine sufficient area. *Clinical Endocrinology (Oxf).* 2000; **53**: 725-731.

38- Negro R, Formoso G, Mangieri T, et al. Levothyroxine treatment in euthyroid pregnant women with autoimmune thyroid disease: effects on obstetrical complications. *The Journal of Clinical Endocrinology and Metabolism*. 2006 ; **91**:2587–2591

39- Moleti M, Trimarchi F , Tortorella G , Candia Longo A et al. Effects of maternal iodine nutrition and thyroid status on cognitive development in offspring: a pilot study. Thyroid 2015 Nov 20. [Epub ahead of print] PMID: 26586553.

40- Andersen S, Karmisholt J, Pedersen KM, Laurberg P. Reliability of studies of iodine intake and recommendations for number of samples in groups and individuals. Br J Nutr. 2008; 99:813-818.

41- Korenek A , Prochazka M. Iodine in early pregnancy- is there enough? Biomed Pap Med Fac Univ Palacky Olomouc Czech Repub. 2008; **152**(1):97-9.

42- Raverot V , Bournaud C, Sassolas G, et al. Pregnant French women living in the Lyon area are iodine deficient and have elevated serum thyroglobulin concentrations. *Thyroid.* 2012; **22:** 522-528

43- Zimmermann MB. Iodine deficiency in pregnancy and the effects of maternal iodine supplementation on the offspring: a review. *The American Journal of Clinical Nutrition.* 2009; **89**:668S–672S

44- Qian M, Wang D, Watkins WE, et al. The effects of iodine on intelligence in children: a meta-analysis of studies conducted in China. Asia Pac J Clin Nutr 2005; **14**: 32-42

45- Caldwell KL, Makhmudov A, Ely E, Jones RL, Wang RY. Iodine Status of the U.S Population, National Health and Nutrition Examination Survey, 2005-2006 and 2007-2008. *Thyroid.* 2011; **21**:419- 427

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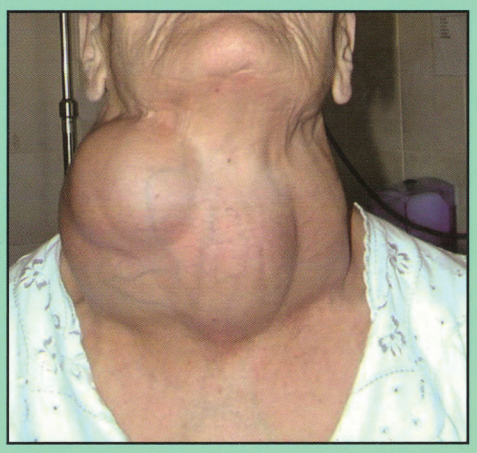

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