UNIVERSIDADE FEDERAL DE UBERLÂNDIA
FACULDADE DE MEDICINA
PROGRAMA DE PÓS GRADUAÇÃO EM CIÊNCIAS DA SAÚDE

ANÁLISE DA UTILIDADE DA ULTRASSONOGRAFIA NA QUANTIFICAÇÃO DA GORDURA VISCERAL, GORDURA PERIRRENAL E GORDURA SUBCUTÂNEA EM PORTADORES DE SÍNDROME METABÓLICA E ASSOCIAÇÃO COM FATORES DE RISCO CARDIOVASCULAR

Leonardo Silva Roever Borges

Universidade Federal de Uberlândia

Faculdade de Medicina

2019

UNIVERSIDADE FEDERAL DE UBERLÂNDIA
FACULDADE DE MEDICINA
PROGRAMA DE PÓS GRADUAÇÃO EM CIÊNCIAS DA SAÚDE

ANÁLISE DA UTILIDADE DA ULTRASSONOGRAFIA NA QUANTIFICAÇÃO DA GORDURA VISCERAL, GORDURA PERIRRENAL E GORDURA SUBCUTÂNEA EM PORTADORES DE SÍNDROME METABÓLICA E ASSOCIAÇÃO COM FATORES DE RISCO CARDIOVASCULAR

Tese de Doutorado apresentada ao Programa de Pós-Graduação em Ciências da Saúde da Faculdade de Medicina da Universidade Federal de Uberlândia

Universidade Federal de Uberlândia

Faculdade de Medicina
2019

Ficha Catalográfica Online do Sistema de Bibliotecas da UFU
com dados informados pelo(a) próprio(a) autor(a).

B732
2019

Borges, Leonardo Silva Roever, 1979-
Análise da utilidade da ultrassonografia na quantificação da gordura visceral, gordura perirrenal e gordura subcutânea em portadores de síndrome metabólica e associação com fatores de risco cardiovascular [recurso eletrônico] : ADIPOSITOPATIA ECTÓPICA E FATORES DE RICO CARDIOVASCULARES / Leonardo Silva Roever Borges. - 2019.

Orientador: ELMIRO SANTOS RESENDE.
Tese (Doutorado) - Universidade Federal de Uberlândia, Pós-graduação em Ciências da Saúde.
Modo de acesso: Internet.
Disponível em: http://dx.doi.org/10.14393/ufu.te.2019.2055
Inclui bibliografia.

1. Ciências médicas. I. RESENDE, ELMIRO SANTOS, 1977-, (Orient.). II. Universidade Federal de Uberlândia. Pós-graduação em Ciências da Saúde. III. Título. CDU: 61

Bibliotecários responsáveis pela estrutura de acordo com o AACR2:
Gizele Cristine Nunes do Couto - CRB6/2091
Nelson Marcos Ferreira - CRB6/3074

UNIVERSIDADE FEDERAL DE UBERLÂNDIA

ATA DE DEFESA

Programa de Pós-Graduação em:	Ciências da Saúde				
Defesa de:	Tese de Doutorado Nº 010/PPCSA				
Data:	16 de maio de 2019	Hora de início:	09:30h	Hora de encerramento:	13:30h
Matrícula do Discente:	11513CSD012				
Nome do Discente:	Leonardo Silva Roever Borges				
Título do Trabalho:	Adipositop a ectópica e fatores de risco para ateroesclerose				
Área de concentração:	Ciências da Saúde				
Linha de pesquisa:	3: Fisiopatologia das doenças e dos agravos à saúde				
Projeto de Pesquisa de vinculação:	Remodelação cardiovascular				

Reuniu-se na sala da Telemedicina do Hospital de Clínicas, Campus Umuarama, da Universidade Federal de Uberlândia, a Banca Examinadora, designada pelo Colegiado do Programa de Pós-graduação em Ciências da Saúde, assim composta: Professores Doutores: Nayara Yamada Tamburús (UNIMEP); Renato Delascio Lopes (Duke Clinical Research Instute) por web conferência; Nilson Penha Silva (IBTEC/UFU); Angélica Lemos Debs Diniz (FAMED/UFU) e Elmiro Santos Resende (FAMED/UFU) orientador do candidato.

Iniciando os trabalhos o presidente da mesa, Dr. Elmiro Santos Resende, apresentou a Comissão Examinadora e o candidato, agradeceu a presença do público, e concedeu ao Discente a palavra para a exposição do seu trabalho. A duração da apresentação do Discente e o tempo de arguição e resposta foram conforme as normas do Programa.

A seguir o senhor(a) presidente concedeu a palavra, pela ordem sucessivamente, aos(às) examinadores(as), que passaram a arguir o(a) candidato(a). Ulmada a arguição, que se desenvolveu dentro dos termos regimentais, a Banca, em sessão secreta, atribuiu o resultado final, considerando o(a) candidato(a):

Aprovado.

Esta defesa faz parte dos requisitos necessários à obtenção do tulo de Doutor.

O competente diploma será expedido após cumprimento dos demais requisitos, conforme as normas do Programa, a legislação pernente e a regulamentação interna da UFU.

Nada mais havendo a tratar foram encerrados os trabalhos. Foi lavrada a presente ata que após lida e achada conforme foi assinada pela Banca Examinadora.

Documento assinado eletronicamente por **Nayara Yamada Tamburus**, **Usuário Externo**, em 16/05/2019, às 13:42, conforme horário oficial de Brasília, com fundamento no art. 6º, § 1º, do Decreto nº 8.539, de 8 de outubro de 2015.

Documento assinado eletronicamente por **Renato Delascio Lopes**, **Usuário Externo**, em 16/05/2019, às 13:46, conforme horário oficial de Brasília, com fundamento no art. 6º, § 1º, do Decreto nº 8.539, de 8 de outubro de 2015.

Documento assinado eletronicamente por **Nilson Penha Silva**, **Membro de Comissão**, em 16/05/2019, às 14:20, conforme horário oficial de Brasília, com fundamento no art. 6º, § 1º, do Decreto nº 8.539, de 8 de outubro de 2015.

Documento assinado eletronicamente por **Angélica Lemos Debs Diniz**, **Professor(a) do Magistério Superior**, em 16/05/2019, às 22:01, conforme horário oficial de Brasília, com fundamento no art. 6º, § 1º, do Decreto nº 8.539, de 8 de outubro de 2015.

Documento assinado eletronicamente por **Elmiro Santos Resende**, **Presidente**, em 20/05/2019, às 15:03, conforme horário oficial de Brasília, com fundamento no art. 6º, § 1º, do Decreto nº 8.539, de 8 de outubro de 2015.

A auten cidade deste documento pode ser conferida no site h ps://www.sei.ufu.br/sei/controlador_externo.php?acao=documento_conferir&id_orgao_acesso_externo=0, informando o código verificador **1252776** e o código CRC **F31A7577**.

À minha
família,pelo estímulo, carinho e
compreensão;por quem todos os meus
sacrifícios,lutas e eventuais glórias são
motivados.

Agradecimentos

Ao Professor Dr. Elmiro Santos Resende, pela amizade, compreensão, dedicação, estímulo, tolerância e orientações durante toda a elaboração da tese.

À Professora Dra. Angélica Lemos Debs Diniz, pela cuidadosa elaboração, realização, validação do método para a mensuração da gordura abdominal e orientações durante a elaboração da tese.

Ao Professor Dr. Nilson Penha Silva, pela fundamental e imensurável leitura crítica do texto e ensinamentos essenciais principalmente em questões referentes à bioestatística e metodologia.

A Universidade Federal de Uberlândia, pelo apoio; aos colegas, funcionários e a todos, que direta ou indiretamente, fizeram parte desta tese, atuando como um grupo coeso e determinado, sem o qual nada disso poderia acontecer.

Epígrafe

❝ O conhecimento científico é como um farol em meio à escuridão da ignorância que estimula a capacidade de pensar e que suscita muitas questões evolucionárias, que podem abrir novas perspectivas para a prevenção, tratamento e melhora da qualidade de vida.❞

(Leonardo Silva Roever Borges)

Sumário

Página

Resumo

Introdução: A Síndrome Metabólica (SM) reúne um conjunto de fatores de risco pró-aterogênicos e pró-trombóticos que, muitas vezes, culminam em morte prematura provocada por doença cardiovascular aterosclerótica e seus eventos isquêmicos.

Objetivos: Analisar a utilidade da ultra-sonografia (US) abdominal para aquantificação da gordura subcutânea (GSC), visceral (GV) e peri-renal (GPR), em voluntários saudáveis e em portadores de SM, correlacionando as medidas obtidas com as variáveis ligadas ao maior risco de eventos isquêmicoscardiovasculares.

Métodos: Foi realizado um estudo transversal, inicialmente com 101 voluntários, para validação do método de medida ultrassonográfico.A partir de medidas das gorduras visceral, peri-renal e subcutânea foram realizadas análises de correlação com as diversas variáveis ligadas ao diagnóstico clínico da síndrome metabólica.

Resultados: Os valores destas medidas apresentaram correlações lineares significantes com variáveis associadas à SM. Os valores de GV apresentaram correlações positivas significantes com a glicemia (Glc), circunferência da cintura (CC), triglicérides (TG), transaminase glutâmica-pirúvica (TGP), pressão sistólica (PAS), além de uma correlação positiva limítrofe com os valores de γGT. Os valores de GPR apresentaram correlações positivas significantes com CC, TG, HDL-C, LDL-C, CT, TGP, PAS e PAD. Os valores de GVP apresentaram correlações positivas com Glc, CC, TG, TGP, PAS e PAD, além de uma correlação positiva limítrofe com a γGT.

Conclusão: A US abdominal é um método útil na avaliação da GSC, da GV e da GPR e estas medidas apresentam correlações positivas com as principais variáveis ligadas ao diagnóstico de SM.

Descritores: Gordura visceral; Ultrassonografia; Síndrome metabólica; Risco cardiovascular.

Abstract

Background: The metabolic syndrome (MS) brings together a number of pro-atherogenic and pro-thrombotic risk-factors, which often culminate in premature death caused by atherosclerotic cardiovascular disease and ischemic events.

Objectives: To evaluate the usefulness of ultrasonography (US) in the quantification of abdominal subcutaneous (SCF), visceral (VF) and peri-renal (PRF) fat deposits in healthy volunteers and in patients with MS, correlating the measurements obtained with the variables linked to increased risk of ischemic cardiovascular events.

Methods: A cross-sectional study was carried out, initially with 101 volunteers, to validate the ultrasound measurement method. Correlation analyzes were performed using visceral, perinenal and subcutaneous fat measurements with the various variables linked to the clinical diagnosis of the metabolic syndrome.

Results: The values of VF showed significant positive correlations with glucose (GLC), waist circumference (WC), triglycerides (TG), glutamic oxaloacetic transaminase (GPT), systolic blood pressure (SBP), diastolic blood pressure (DBP), and a positive borderline correlation with gamma- glutamyl-transferase (γGT). The values of PRF showed significant positive correlations with WC, TG, HDL-C, LDL-C, total cholesterol (TC), GPT, SBP and DBP.. The values of PRF showed positive correlations with GLC, WC, TG, GPT, SBP and DBP, and a positive borderline correlation with γGT.

Conclusion: The abdominal US is a valid and reproducible method in the evaluation of VF, PRF andSCF, which have positive correlations with the main variables linked to MS.

Keywords: Visceral Fat, Ultrasonography, Metabolic Syndrome, Cardiovascular Risk

Abreviaturas

AgRP	Proteína *Agouti*-relacionada
ASP	Proteína estimuladora de acilação
C	Colesterol
CAT	Transcrito regulado por cocaína e anfetamina
CC	Circunferência da cintura
CT	Colesterol total
DM1	Diabetes mellitus do tipo 1
DM2	Diabetes mellitus do tipo 2
GH	Hormônio do crescimento
GPR	Gordura Peri-renal
GSC	Gordura subcutânea
GV	Gordura visceral
GVPR	Soma das gorduras visceral (GV) e peri-renal (GPR)
HCU	Hospital de Clínicas da Universidade Federal de Uberlândia
HDL	Lipoproteína de alta densidade
HDL-C	HDL - Colesterol
IGF-1	Fator de crescimento 1 do tipo da insulina
IL-6	Interleucina 6
IMC	Índice de massa corporal
LDL	Lipoproteína de baixa densidade
LDL-C	LDL Colesterol
NPY	Neuropeptídeo Y
PAD	Pressão arterial diastólica
PAI-1	Inibidor da ativação do plasminogênio
PAS	Pressão arterial sistólica
PCR	Proteína C Reativa

POMC	Pro-Ópio-Melano-Cortina
RI	Resistência àinsulina
SM	Síndromemetabólica
TE	Teste ergométrico
TG	Triglicérides
TGO	Transaminaseglutâmica-oxaloacética
TGP	Transaminase glutâmica-pirúvica
TNF-α	Fator de necrosetumoral
TSH	Hormônio estimulante da tireóide
VLDL	Lipoproteína de densidade muito baixa
VLDL-C	Lipoproteína de densidade muito baixa
γGT	γ-Glutamiltransferas

Introdução

A Síndrome Metabólica (SM) reúne um conjunto de fatores de risco pró-aterogênicos e pró-trombóticos e muitas vezes culmina em morte prematura provocada por doença cardiovascular aterosclerótica e seus eventos isquêmicos. Os pacientes portadores desta síndrome têm, em relação à população normal, a mortalidade geral aumentada em 1,5 vezes, o risco cardiovascular entre 1,5 e 3 vezes e 5 vezes mais risco para desenvolver *diabetes mellitus* tipo 2 (DM2). Há ainda maior tendência ao desenvolvimento de insuficiência renal e de certos tipos de câncer. [1-23]

A hipótese atual para explicar a origem da SM relaciona um conjunto de anormalidades metabólicas que se desenvolvem progressivamente e que, geralmente, estão ligadas a uma base fisiopatológica comum com estreita vinculação à genética,inatividade física, dieta inadequada (excesso de sal, gorduras, açúcar e álcool), obesidade, disfunção neuroendócrina e imunológica e estresse emocional exacerbado. A adipositopatia centrípeta e a resistência à insulina[21,114] potencializam o dano e o desgaste do arsenal molecular estrutural da célula necessário à sua estabilidade funcional. Vale concluir que nenhum dos mecanismos das teorias aqui descritas é bem conhecido, o que reforça a necessidade de novos estudos abordando o tema em seus aspectos fisiopatológicos, terapêuticos e preventivos.

Prevalência

Dentre os fatores acima relacionados, o ganho de peso é visto como um preditor independente para o desenvolvimento da SM, embora nem todos os indivíduos obesos a desenvolvam. Por outro lado, certas populações com baixa prevalência de obesidade apresentam elevada prevalência da SM e um considerável aumento da morbi-mortalidade cardiovascular.[1-23]

Estima-se que a SM acometa 24% da população adulta, dependendo do critério de diagnóstico utilizado. Estudos de prevalência em diferentes populações, como a norte-americana, a asiática e a mexicana, indicam taxas que variam de 12,4% a 28,5% em homens e de 10,7% a 40,5% em mulheres.[7,9,15,16] Esta variabilidade decorre, em grande parte, da imprecisão dos critérios utilizados para o diagnóstico.

No Brasil não existe um estudo nacional quanto à prevalência da SM mas, dados isolados, indicam que cerca de 38% das mulheres e 18% dos homens adultos apresentamessasíndrome.[12-20]Conjuntamente,destaca-se, em, nossopaísoaumentoda

prevalência da obesidade, especialmente em crianças em idade escolar, adolescentes e nos extratos de mais baixa renda. A adoção de estilos de vida relacionados à boa saúde, como uma dieta adequada e a prática regular de atividade física, preferencialmente desde a infância, são componentes básicosna prevenção da obesidade e daSM.[21]

Com esse objetivo, portanto, ênfase especial deve ser dada aos aspectos nutricionais de nossa população. Uma alimentação adequada deve permitir a manutenção do balanço energético e do peso saudável. A redução da ingestão de calorias sob a forma de gorduras, principalmente saturadas e trans, e de carboidratos, incentivando-se o aumento do consumo de frutas, leguminosas, cereais integrais e hortaliças, ajudam a manutenção do peso corporal adequado.[24-28]

Além da ingestão calórica aumentada, um baixo condicionamento cardiorrespiratório, pouca atividade muscular e sedentarismo contribuem para a obesidade. A prática regular de exercícios físicos deve ser a meta desejável para toda a população, no sentido de se alcançar um padrão satisfatório do peso corporal. [29-33]

Quanto a esses aspectos, deve ser mencionado que todos os itens relacionados aos hábitos compatíveis com uma vida saudável devem ser enfocados em conjunto por programas específicos de prevenção e manutenção do peso corporal.[21]

Não há um consenso mundial quanto ao melhor critério para o diagnóstico da SM. Isto é uma constatação particularmente importante no que diz respeito aos pontos de corte dos valores considerados normais nos diversos itens que compõem a SM. Tais dúvidas implicam em grandes dificuldades de diagnóstico e tratamento com repercussões nas práticas clínicas e nas políticas de saúde instituídas.[21]

Critério diagnóstico

O critério diagnóstico estabelecido na I Diretriz Brasileira de Diagnóstico e Tratamento da Síndrome Metabólica, que adotou na íntegra o estabelecido pelo *National Cholesterol Education Program's Adult Treatment Panel III*, inclui a presença de três ou mais dos seguintes itens: 1) diâmetro de cintura > 102 cm para homens e > 88 cm para mulheres; 2) triglicérides $\geq$ 150 mg/dl; 3) HDL-colesterol < 40 mg/dl para homens e < 50 mg/dl para mulheres; 4) PAS $\geq$ 130 mmHg e PAD $\geq$ 85 mmHg; 5) glicemia de jejum $\geq$ 110 mg/dl e < 126 mg/dl[21]. Em recomendação mais recente da American Diabetes Association, o diagnóstico de glicemia de jejum alterada passa a ser feito a partir de valores de 100 mg/dl, o que poderá influenciar no critério diagnóstico da SM.[21]Uma atualização sobre esta questão foi recentemente publicada pela Sociedade Brasileira de Diabetes.[22]

De todos esses componentes da SM, uma grande ênfase é dada à circunferência abdominal determinada facilmente pela medida feita no meio da distância entre asrebordas costais direita e esquerda e a crista ilíaca.[34-36] Este é o índice antropométrico mais representativo da gordura abdominal, é de aferição simples e reprodutível, sendo a medida recomendada como um dos componentes fundamentais para o diagnóstico da SM.[21, 22] No entanto, ela não permite separar os componentes subcutâneo e perivisceral da gordura abdominal, o que implica em aspectos fisiopatológicos diferentes como veremosabaixo.

Pontos de corte

Os pontos de corte do diâmetro máximo desejável da cintura abdominal têm sido questionados por não se adequarem a populações de diferentes etnias com biótipos diferenciados. Em alguns estudos, valores de 94 cm para homens e de 80 cm para mulheres têm sido considerados mais apropriados. Desta maneira, recomenda-se a monitoração repetida quando a circunferência da cintura estiver entre 94 e 102 cm, para homens, e entre 80 e 88 cm, para mulheres, pela mais frequente associação de valores superiores de circunferência abdominal com fatores de risco para doenças coronarianas.[21]

Como componente fundamental para o aumento da circunferência abdominal, a localização do depósito de gordura precisa ser melhor considerado. Nos últimos anos, o tecido adiposo e sua localização deixaram de ser vistas apenas como sendo um reservatório de energia para ser reconhecido como órgão endócrino com múltiplas funções e representando um papel central na gênese da resistência à insulina (RI). [37-38,113]

Fisiopatologia

Os adipócitos são as unidades celulares mais importantes no tecido adiposo. Recebem a influência de diversos agentes, como a insulina, GH, IGF-1, cortisol e catecolaminas, e, em resposta, secretam uma grande variedade de substâncias que atuam tanto local como sistemicamente, participando da regulação de diversos processos como a função endotelial, a aterogênese, a sensibilidade à insulina e o balanço energético.[39-41,110]

A associação da adiposidade abdominal com os componentes da síndrome metabólica está bem estabelecida. Pacientes com maior grau de resistência à insulina apresentam, via de regra, maior deposição intra-abdominal de gordura[42]. Há uma nítida correlação positiva entre a gordura visceral e a insulinemia, a glicemia dosada 2 horas

após sobrecarga oral de glicose, os níveis séricos de triglicerídeos e a pressão arterial.[43-48]

Diversos autores apontam a estreita relação existente entre a gordura visceral e a resistência à insulina e o risco cardiovascular elevado e estudos sugerem que a obesidade visceral também possa contribuir para o desenvolvimento de doença arterial coronariana em indivíduos não-obesos.[42] O risco cardiovascular aumentado pode estar vinculado ao seu papel regulador endócrino decorrente da produção e liberação de várias substâncias. Algumas delas, como a leptina, a adiponectina, a resistina, o angiotensinogênio, a visfatina, a adipsina, a proteína estimuladora da acilação (ASP), inibidor da ativação do plasminogênio (PAI-1), o fator de necrose tumoral-α(TNF-α), a interleucina 6, dentre outras, têm papel fundamentalno metabolismo e na sensibilidade tecidual à insulina. [37-39,41,49]

A título de maior ilustração algumas propriedades de cada uma dessas substâncias serão comentadas abaixo.

A leptina é produzida por adipócitos diferenciados e age no hipotálamo, sobre o núcleo arqueado, ativando populações de neurônios anorexígenos aí localizados, onde estimula a expressão de neuropeptídeos ligados aos mecanismos de inibição alimentar (pro-ópio-melano-cortina[POMC] e o transcrito relacionado a cocaína e anfetamina [CART], que inibem a ingestão alimentar e aumentam o gasto energético total, via inervação simpática) e também age inibindo outros neurônios orexígenos (que expressam o neuropeptídeo Y [NPY] e a proteína *Agouti*-relacionada [AgRP]), suprimindo a ingestão de alimentos e estimulando o gasto energético. A leptina também age diretamente nos macrófagos, aumentando a sua ação fagocítica e sua capacidade de produção de citocinas que desempenham um papel relevante na inflamação associada à aterosclerose**.** [61-63,97]

A adiponectina é secretada pela célula adiposa e possui propriedades sensibilizadoras à ação da insulina. Também age como potente agente anti-inflamatório, inibindo uma série de processos envolvidos no desenvolvimento da aterosclerose. Estes mecanismos não estão totalmente elucidados, mas alguns são bem reconhecidos. Dentre estes, a redução dos níveis circulantes de ácidos graxos livres pelo aumento da oxidação de gordura pela musculatura esquelética e o estímulo direto à captação de glicose no músculo e adipócitos pela ativação da AMP-kinase (AMPK) [64-67,111]são especialmente importantes.

A resistina está relacionada à glicemia e à captação de glicose. Quando injetada

em animais produz um estado de resistência à insulina e em humanos com DM2 ocorre elevação de seus níveis plasmáticos. [68-69]

A fonte principal de produção do angiotensinogênio é o fígado. No entanto, as células adiposas representam também um importante local de expressão e produção desta substância. O angiotensinogênio está elevado na obesidade e, como consequência, há também alta produção de angiotensina II, um potente vasoconstrictor que está implicado no processo de aterosclerose e na inibição da cascata de ação insulínica. [70-71]

OPAI-1 é responsável pela ativação da cascata fibrinolítica. Níveis elevados de PAI-1 são encontrados na SM, o que favorece a formação de trombos e agrava o processo de aterosclerose. [72-73]

As chamadas citocinas inflamatórias estão relacionadas à SM. Dentre estas, o TNF-αestá elevado na obesidade e no DM2; quando o TNF-αé infundido experimentalmente em roedores, observa-se intensa resistência à insulina, estímulo à lipólise e ativação de várias vias componentes do processo inflamatório.[74-75]

Além do TNF-α, a interleucina-6 (IL-6) também é produzida pelos adipócitos e desempenha um papel fundamental na regulação da função da célula β em humanos com DM2. Os níveis elevados de IL-6 se associam à intolerância à glicose e à inflamação que pode ser evidenciada pelos níveis também elevados de proteína C reativa (PCR) no sangue.[76-77]

A adipsina e a proteína estimuladora de acilação (ASP) são liberadas pelos adipócitos. A ASP aumenta o depósito de lipídeos elevando a captação de glicose e sua deposição como triglicérides. Existem aumentos moderados de adipsina e intensos de ASP na obesidade e no DM2 em humanos. [78-79]

A visfatina possui uma ação intrigante exercendo uma ação hipoglicemiante semelhante à da insulina, mas seu papel definitivo ainda permanece alvo de especulações.[80]

A participação do tecido adiposo na SM dependende de sua localização. É conhecido que os adipócitos situados no compartimento intra-abdominal ou perivisceral secretam substâncias diferentes daqueles posicionados no tecido subcutâneo. É, portanto, a adiposidade intra-abdominal que apresenta maior impacto na deterioração da sensibilidade dos tecidos à insulina.[43] Dessa maneira, na determinação da gordura abdominal é preciso diferenciar onde está localizado o depósito principal, pois as consequências disso podem serdiferentes.

Na avaliação da gordura corporal, a antropometria tem a vantagem de ser de

fácil execução e de não necessitar de material ou pessoal especializado. Tem, porém, as desvantagensdeserincapazdediferenciaragorduraviscerealdasubcutânea, alémdecontar com uma variabilidade relativamente elevada na aferição intra e inter- examinadores.[42] A partir da determinação do peso e da altura do indivíduo pode-se calcular o IMC, o qual é empregado para a classificação dos diversos graus de obesidade que, em estudos epidemiológicos, se associam diretamente ao risco crescente de morbi-mortalidade. Todavia, o IMC é limitado para determinar qual dos "componentes" corporais (por exemplo, gordura visceral ou subcutânea) encontra-se aumentado. [42] Além disso, alguns estudos relatam populações com baixo IMC mascom alta prevalência de SM, o que limita o uso exclusivo deste índice na classificação do risco cardiovascular em indivíduosobesos.[41-50-51]

Outro dado antropométrico de interesse é a medida da circunferência da cintura abdominal (CC). Este é o método mais comumente usado na literatura para avaliar a adiposidade abdominal havendo, como já vimos, sugestões de pontos de corte associados ao maior risco cardiovascular. Todas as propostas de critérios diagnósticos para a síndrome metabólica levam em consideração a obesidade abdominal como um item importante. Como já referido, os valores da CC de 88 cm para mulheres e 102 cm para homens são considerados pontos críticos máximos para essa variável. Na verdade parece haver uma diferença racial na relação entre distribuição de gordura e síndrome metabólica; afro-descendentes e brancos com a mesma quantidade de gordura abdominal têm riscos metabólicos diferentes.[42]

A partir da CC e da circunferência do quadril pode-se calcular a razão cintura-quadril que faz parte dos critérios diagnósticos para SM propostos pela Organização Mundial de Saúde. Entretanto, esta variável vem perdendo espaço para a CC que, por se tratar de uma única medida, esta menos sujeita à variabilidade na mensuração e nas características raciais.[42]

Com todas estas observações, ainda persiste o problema relacionado a não identificação do sítio da obesidade abdominal. Neste sentido, na análise dos depósitos de gordura, a tomografia computadorizada do abdome é considerada o "padrão-ouro" para determinação da gordura abdominal.

Exames de Imagem

A tomografia computadorizada do abdome permite a diferenciação da adiposidade subcutânea e visceral. As razões para a tomografia computadorizada ser considerada o melhor método de imagem para avaliação dos componentes corporais

baseiam-se na sua elevada reprodutibilidade e nos coeficientes de correlação superiores a 0,90.[52-54]

Assim, a área de gordura visceral mensurada em um único corte tomográfico obtido na altura da cicatriz umbilical (L3-L4 ou L4-L5) mostra-se fortemente correlacionada ao volume total de gordura visceral, o que justifica o emprego deste método para o diagnóstico da deposição de gordura. [54]

A partir destas mensurações, torna-se possível calcular a razão entre as áreas visceral e subcutânea da gordura abdominal, demonstrando-se a associação da razão $\geq$ 0,4 ou de uma área de gordura intra-abdominal $\geq$ 130 cm^2 com distúrbios do metabolismo glico-lipídico. Entretanto, a necessidade de equipamento sofisticado e pessoal especializado, seu alto custo e a exposição do indivíduo à irradiação, além de dificuldades existentes em exames de pacientes muito obesos, limitam seu uso na rotina clínica e em estudos epidemiológicos. [55]

A DEXA (*dual energy x-ray absorptiometry*), amplamente utilizada na avaliação da densidade mineral óssea, também é capaz de mensurar a adiposidade corporal total e regional[24]. Ela é aplicada para medir a gordura de localização abdominal (componentes subcutâneo e visceral, conjuntamente) e para rastrear pacientes de alto risco cardiovascular[24]. Porém, a exposição à radiação, necessidade de equipamento e pessoal especializado também limitam seu uso na prática clínica e em estudos populacionais. [56]

A ressonância nuclear magnética também permite estimar a gordura visceral com boa acurácia entretanto ela está mais sujeita a artefatos que a tomografia e seu coeficiente de variação também é maior[54], além do custo e de outras limitações para seu usorotineiro.

Todos estes fatos justificam a procura e padronização de um método não invasivo, de baixo custo e com alta acurácia e reprodutibilidade, com poucas limitações técnicas, que o tornem recomendável para análise de grandes populações. Desse modo, métodos alternativos para a avaliação da distribuição central da gordura vêm sendo sugeridos com o objetivo de tornar mais prática e ampla a identificação de indivíduos obesos viscerais, susceptíveis à síndrome metabólica e, portanto, com elevado risco cardiovascular. [24]

Dentre as possibilidades existentes, a ultrassonografia foi recentemente proposta como alternativa para avaliação da adiposidade abdominal diante da boa correlação demonstrada com a gordura visceral determinada pela tomografia computadorizada.[57]

A imagem ultrassonográfica permite visualizar e medir as "distâncias" (em cm)

da gordura abdominal subcutânea e visceral, separadamente.[57-58]

Apesar de requerer equipamento e pessoal especializados, à semelhança de outros métodos, é significativamente menos dispendiosa que a tomografia computadorizada. Trata-se de um método inócuo, de fácil e rápida execução, com boaespecificidade e reprodutibilidade. Estas características apontam a ultrassonografia como uma alternativa potencialmente útil no estudo da obesidade abdominal, permitindo separar os componentes peri-visceral e subcutâneo em pacientes de alto risco para a SM. [42,59,60,96]

Diante da atual epidemia mundial de SM e do reconhecido impacto para a morbidade e mortalidade das populações especialmente em decorrência de eventos cardiovasculares, relacionados à distribuição central de gordura, é importante o acesso a métodos práticos, seguros, eficazes e de baixo custo para a identificação de indivíduos com adiposidade intra-abdominal aumentada.[59-119] Este diagnóstico pode indicar a necessidade de intervenções profiláticas ou terapêuticas precoces nestes indivíduos.

Objetivo

O objetivo do presente estudo é analisar a utilidade da ultrassonografia na quantificação da gordura subcutânea (GSC), visceral (GV) e perirrenal (GPR), em voluntários saudáveis e em portadores de SM, correlacionando as medidas obtidas com as variáveis ligadas ao maior risco de eventos isquêmicos cardiovasculares.

- **A seguir são apresentados os artigos publicados conforme o modelo vigente da pós-graduação na presente data.**

Artigo 1 - Abdominal Obesity and Association with Atherosclerosis Risk Factors

Artigo 2 - Perirenal Fat and Association With Metabolic Risk Factors

Artigo 3 - Ectopic adiposopathy and association with cardiovascular disease risk factors: The Uberlândia Heart Study

Medicine®

OBSERVATIONAL STUDY

Abdominal Obesity and Association With Atherosclerosis Risk Factors

The Uberlândia Heart Study

Leonardo S. Roever, MHS, Elmiro. S. Resende, PhD, Angélica. L. D. Diniz, PhD, Nilson Penha-Silva, PhD, Fernando. C. Veloso, MHS, Antonio Casella-Filho, PhD, Paulo .M.M. Dourado, PhD, and Antonio .C.P. Chagas, PhD

Abstract: Ectopic visceral fat (VF) and subcutaneous fat (SCF) areassociated with cardiovascular risk factors. Gender differences in the correlations of cardiovascular disease risk factors and ectopic fat in the Brazilian population still lacking.

Cross-sectional study with 101 volunteers (50.49% men; mean age 56.5 18, range 19–74 years) drawn from the Uberlaˆndia Heart Study underwent ultrasonography assessment of abdominal visceral adipose tissue with convex transducer of 3.5 MHz of frequency. The thickness of VF was ultrasonographically measured by the distance between the inner face of the abdominal muscle and the posterior face of abdominal aorta, 1 cm above the umbilicus. The SCF thickness was measured with a 7.5 MHz linear transducer transversely positioned 1 cm above the umbilical scar. The exams were always performed by the same exam-iner. Ectopic fat volumes were examined in relation to waist circum-ference, blood pressure, and metabolic risk factors.

The VF was significantly associated with the levels of triglycerides ($P < 0.01$, $r = 0.10$), HDL cholesterol ($P < 0.005$, $r = 0.15$), total choles-terol ($P < 0.01$, $r = 0.10$), waist circumference ($P < 0.0001$, $r = 0.43$), systolic blood pressure ($P < 0.001$, $r = 0.41$), and diastolic blood pressure ($P < 0.001$, $r = 0.32$) in women, and with the levels of triglycerides ($P < 0.002$, $r = 0,14$), HDL cholesterol ($P < 0.032$, $r = 0.07$), glucose ($P < 0.001$, $r = 0.15$), alanine aminotransferase (ALT) ($P < 0.008$, $r = 0.12$), gamma-GT ($P < 0.001$, $r = 0.30$), waist circumference ($P < 0.001$, $r = 0.52$), systolic blood pressure ($P < 0.001$, $r = 0.32$), and diastolic blood pressure ($P < 0.001$, $r = 0.26$) in men. SCF was signifi-cantly associated with the levels of triglycerides ($P < 0.01$, $r = 0.34$), LDL cholesterol ($P < 0.001$, $r = 0.36$), total cholesterol ($P < 0.05$, $r = 0.36$), waist circumference ($P < 0.0001$, $r = 0.62$), systolic and diastolic blood pressure ($P < 0.05$, $r = 0.34$) in women, and with the waist circumference ($P < 0.001$, $r = 0.065$)), and MetS ($P < 0.05$, $r = 0.11$) in men.

The VF and SCF were correlated with most cardiovascular risk factors in both genders but our findings support the idea that there are gender differences in the correlations between ectopic fat deposition and the cardiovascular risk factors.

Editor: Leonardo Gilardi.
Received: June 18, 2015; revised and accepted: July 9, 2015.
From the Federal University of Uberlaˆndia (LR, ESR, ALDD, NP-S, FCV), Heart Institute (InCor), HCFMUSP, University of Saˆo Paulo Medical School, Saˆo Paulo (AC-F, PMMD, ACPC), and Faculty of Medicine ABC, Santo Andre´ (ACPC), Brazil.
Correspondence: Leonardo S. Roever-Borges, Department of Clinical Research, Av. Para´, 1720, Bairro Umuarama Uberlaˆndia, MG, CEP 38400-902, Saˆo Paulo, Brazil (e-mail: leonardoroever@hotmail.com).
The authors have no conflicts of interest to disclose.
 ISSN: 0025-7974

DOI: 10.1097/MD.0000000000001357

(Medicine 95(11):e1357)

Abbreviations: ALT = alanine aminotransferase, AST = asparatate transaminase, BMI = body mass index, CT = computed tomography, CVD = cardiovascular disease, GGT = gamma glutamyl transferase, HDL-C = high density lipoprotein cholesterol, HOMA-IR = Homeostatic Model Assessment for Insulin Resistance, LDL-C = low density lipoprotein cholesterol, M = men, MetS = metabolic syndrome, MRI = magnetic resonance imaging, non-HDL = nonhigh density lipoprotein cholesterol, SCF = subcutaneous fat, VF = visceral fat, W = women, WC = waist circumference.

INTRODUCTION

Cardiovascular disease (CVD) is the leading cause of mor-bidity and mortality in the world. Ectopic fat is a risk factor for multiple CVD risk factors, including hypertension, dyslipidemia, diabetes, and the metabolic syndrome (MetS).[1–5] In particular, the visceral fat (VF) compartment may be a patho-genic fat depot. VF has been termed an endocrine organ, in part because it secretes adipocytokines and other vasoactive substances that can influence the risk of developing metabolic traits.[6–10]

Waist circumference (WC) is an imprecise measure of abdominal adiposity because it is a function of both the subcu-taneous fat (SCF) and VF compartments.[7] Available studies report relations of greater SAT and VF with a higher prevalence of impaired fasting glucose, diabetes, insulin resistance, hyperten-sion, lipids, MetS, inflammation, and risk factor clustering.[8,11–24]

The aim of this study was to analyze the association among SCF and VF and other obesity-related parameters, such as waist circumference, blood pressure, and metabolic risk factors.

METHODS

Study Sample

This prospective cross-sectional case–control study with 101 volunteers (50.49% men; mean age 56.5 18, range 19–74 years) drawn from the Uberlândia Heart Study underwent ultrasonography assessment of abdominal adipose tissue. The study was a random sample of individuals that required medical service hospital. The study was approved by the institutional review boards of the Federal University of Uberlaˆndia. All subjects provided written informed consent. All patients received the first diagnosis of related disorders in the study, and did not use medications that affected the lipid profile, blood pressure, and blood glucose. Those with kidney liver or chronic respiratory failure, as well as subjects with severe apnea, morbid

obesity, cancer, neurodegenerative diseases, or receiving psychiatric medications were excluded.

Abdominal Adipose Tissue Measurements

The ultrasound examination was performed always by the same examiner with an equipment Versa-Pro (Siemens, Erlan-gen, Germany), using the preset for abdominal examination. The Assessment of abdominal visceral adipose tissue was done with convex transducer of 3.5 MHz of frequency. The thickness of VF was ultrasonographically measured by the distance between the inner face of the abdominal muscle and the posterior face of abdominal aorta, 1 cm above the umbilicus (Figure 1). The SCF thickness (Figure 2) was measured with a 7.5 MHz linear transducer transversely positioned 1 cm above the umbilical scar. During the ultrasound scan, the examiner took care not to press the transducer in the abdomen, in order to not underestimate the thickness of the subcutaneous.

Risk Factor and Covariate Assessment

Risk factors and covariates were measured at the contem-poraneous examination. Body mass index (BMI), defined as weight (in kilograms) divided by the square of height (in meters), was measured at each index examination. WC was measured at the level of the umbilicus. Abdominal obesity was defined as 80 cm in women and 94 cm in men. Hypertension was defined as systolic blood pressure 130 mmHg, diastolic blood pressure 85 mmHg. Total, high-density lipoprotein (HDL-C) and low density lipoprotein (LDL-C) cholesterol, and triglycerides were measured on fasting morning samples. Non-HDL-C is easily calculated from a lipid profile (non-HDL-C = total cholesterol minus HDL-C). Diabetes was defined as a fasting plasma glucose level 126 mg/dL. Impaired fasting glucose was defined as a fasting plasma glucose level of 100 to 125 mg/dL among those not treated for diabetes. The main outcome measures were age-standardized prevalence of the MetS per the harmonized American Heart Association/National Heart, Lung, and Blood Institute definition and its component abnormalities. The control group was considered which did not have cardiovascular risk factors. Patients after diagnosis needed medication were referred to specialized treatmen

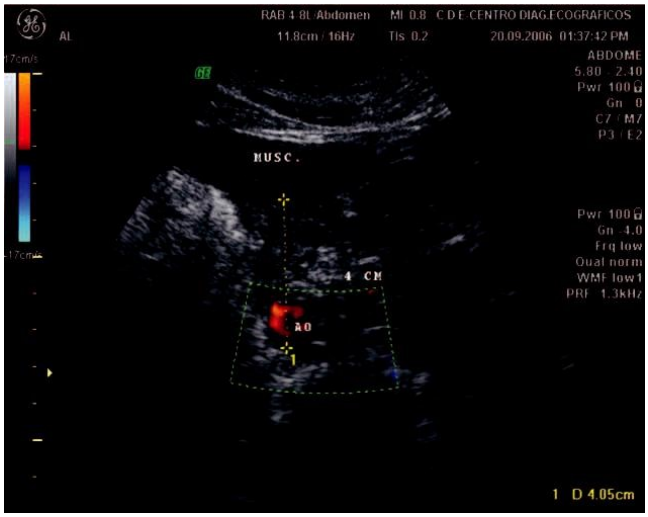

FIGURE 1. The thickness of visceral fat.

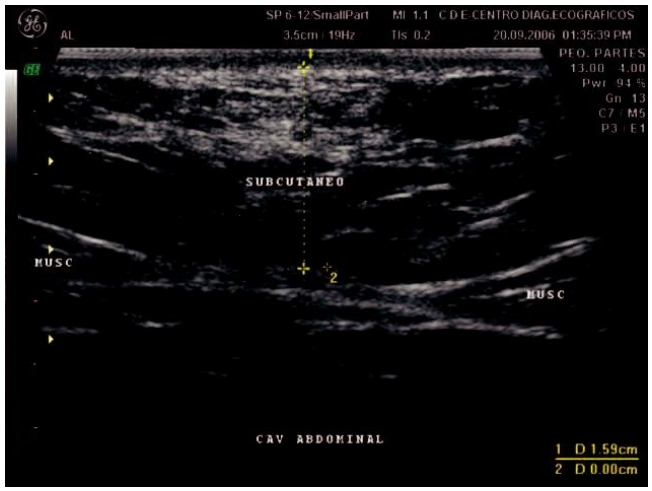

FIGURE 2. The thickness of subcutaneous fat

Statistical Analysis

SCF and VF were normally distributed. Sex-specific age-adjusted Pearson correlation coefficients were used to assess simple correlations between SCF and VF and metabolic risk factors. Multivariable linear and logistic regression was used to assess the significance of covariate-adjusted cross-sectional relations between continuous and dichotomous metabolic risk factors and SCF and VF. A P-value 0.05 was considered to indicate significance. SPSS Version 21 software (SPSS, Chi-cago, IL) was used.

RESULTS

Baseline Characteristics

Overall, 49 women (W) and 52 men (M) were available for analysis. The mean age of the study sample was 48 W and 52 M years, and 48.5% were women (Table 1); 40.2% was hypertensive, 39.3% had obese, 61.8% abdominal obesity, 32% hypertriglyceridemia, 33.2% low HDL-C and high LDL-C, 40.2% high total cholesterol, 33.2% high non-HDL-C, 22.7% mixed dyslipidemia, 20.2% impaired fasting glucose, and 41.1% had MetS. Mean visceral and SCF thick-ness were 4.9 and 2.7 cm in W and 6.8 and 2 cm in M, respectively.

Correlations With VF and SCF

Correlations of VF and SCF with metabolic risk factors are shown in Table 2. VF was significantly associated with the levels of triglycerides ($P < 0.01$, $r = 0.10$), HDL cholesterol ($P < 0.001$, $r = 0.15$), total cholesterol ($P < 0.01$, $r = 0.10$), waist circumference ($P < 0.0001$, $r = 0.43$), systolic blood pres-sure ($P < 0.001$, $r = 0.41$), and diastolic blood pressure ($P < 0.001$, $r = 0.32$) in women, and with the levels of trigly-cerides ($P < 0.002$, $r = 0.14$), HDL cholesterol ($P < 0.032$, $r = 0.07$), glucose ($P < 0.001$, $r = 0.15$), alanine aminotransfer-ase (ALT) ($P < 0.008$, $r = 0.12$), gamma-GT ($P < 0.001$, $r = 0.30$), waist circumference ($P < 0.001$, $r = 0.52$), systolic blood pressure ($P < 0.001$, $r = 0.32$), and diastolic blood pres-sure ($P < 0.001$, $r = 0.26$) in men.

SCF was significantly associated with the levels of triglycerides ($P < 0.01$, $r = 0.34$), LDL cholesterol ($P < 0.001$, $r = 0.36$), total cholesterol ($P < 0.05$, $r = 0.36$)

TABLE 1. Study Sample Characteristics

	Men (52)	Women (49)
Age, y	52 (13)	48 (6.4)
BMI, kg/m^2	25.9 (4.1)	26.3 (3.4)
Overweight (BMI 25 and 30), %	26.9	26.5
Obesity Grade 1 (BMI 30 and 35), %	7.6	18.3
WC, cm	96.2 (11.9)	85.2 (10.9)
WC 94 M and W 80 cm, %	55.7	69.3
Triglycerides, mg/dL	167.6 (39–638)	123.8 (44–490)
Hypertriglyceridemia 150 mg/dL, %	40.3	24.4
HDL cholesterol, mg/dL	45.7 (11.7)	52.2 (11.2)
HDL 40 M and 50 W (mg/dL), %	34.6	32.6
LDL cholesterol, mg/dL	115 (28.4)	119.7 (39.4)
LDL cholesterol, mg/dL 130%	34.6	32.6
Total cholesterol, mg/dL	191.3 (38.4)	196.2 (40.3)
Total cholesterol, mg/dL 200%	36.5	44.8
Non-HDL-C, mg/dL	140.6 (35.7)	141.9 (42)
Non-HDL-C, 160 M and 150 W (mg/dL), %	32.6	34.6
Mixed dyslipidemia, %	13.4	32.6
AST, U/L	17.2 (7.8)	12.9 (2.9)
ALT, U/L	40.3 (23.3)	25.2 (11)
Gamma-GT, U/L	43.7 (34.4)	25.2 (17.1)
Systolic blood pressure, mmHg	126.4 (15.4)	121.3 (16.8)
Diastolic blood pressure, mmHg	84.8 (9.5)	81.5 (9.7)
Hypertension, %	48.7	32.6
Fasting plasma glucose, mg/dL	96.3 (10.8)	90.8 (10.8)
Impaired fasting glucose, %	28.8	12.2
MetS, %	38.4	44.8
Postmenopausal, %	. . .	36.7
Hormone replacement therapy, %	. . .	35.6
SCF, cm	2 (0.8)	2.7 (1)
VF, cm	6.8 (2)	4.9 (1.6)

Data are presented as mean SD when appropriate.

ALT = alanine aminotransferase, AST = asparatate transaminase, BMI = body mass index, GGT = gamma glutamyl transferase, HDL-C = high density lipoprotein cholesterol, LDL-C = low density lipoprotein cholesterol, M = men, MetS = metabolic syndrome, non-HDL = nonhigh density lipoprotein cholesterol, SCF = subcutaneous fat, VF = visceral fat, W = women, WC = waist circumference.

waist circumference (P < 0.0001, r = 0.62), systolic and dias-tolic blood pressure (P < 0.05, r = 0.34) in woman, and with the waist circumference (P < 0.001, r = 0.65)), and MetS (P < 0.05, r = 0.11) in men.

Multivariable-Adjusted Regressions With VF, SCF, and Metabolic Risk Factor Variables

Results of multivariable-adjusted general linear regression analyses for VF and SCF for both continuous and dichotomous metabolic risk factors are shown in Table 3. The VF was significantly associated with the levels of triglycerides (P < 0.01, r = 0.12), waist circumference (P < 0.0001, r = 0.13), systolic blood pressure (P < 0.001, r = 0.44), LDL-C (P < 0.01, r = 0.17), SBP (P < 0.001, r = 0.42), and DBP (P < 0.001, r = 0.33) in women, and with the levels of triglycerides (P < 0,001, r = 0.16), HDL cholesterol (P < 0.05, r = 0.09), glucose (P < 0.001, r = 0.15), ALT (P < 0.05, r = 0.13), gamma-GT (P < 0.0001, r = 0.32), waist circumfer-ence (P < 0.001, r = 0.53), SBP (P < 0.001, r = 0.28), DBP (P < 0.0001, r = 0.34), FPG (P < 0.001, r = 0.02), and MetS (P < 0.001, r = 0.11) in men.

SCF was significantly associated with waist circumference (P < 0.0001, r = 0.18) in women, and with waist circumference (P < 0.001, r = 0.26), SBP (P < 0.05, r = 0.09), and MetS (P < 0.05, r = 0.11) in men.

Sex Interaction

We observed a significant sex interaction, which suggests that SCF are associated with more adverse risk factor profiles in women, and VF in men (Table 3).

DISCUSSION

In the Uberlândia Heart Study, thickness measures of both VF and SCF were correlated with multiple metabolic risk factors, although risk factor correlations with VF were consist-ently significantly stronger than those for SCF. VF was more strongly associated with metabolic risk factors in men than in women after multivariable-adjusted regressions. SCF was more strongly associated with metabolic risk factors in women than in men after correlation.

VF has traditionally been considered the more associated with risk factors compartment compared with SCF, but data confirming these relations in women and men have been lacking

TABLE 2. Sex-Adjusted Pearson Correlation Coefficients Between Metabolic Risk Factors and VF and SCF Thickness

	Men				Women			
	VF		SCF		VF		SCF	
	C	MetS	C	MetS	C	MetS	C	MetS
BMI, kg/m^2	0.18	0.32	0.11	0.41	0.49^z	0	0.39	0.13
WC, cm	0.67^z	0.51z	0.65^z	0.32	0.66^z	0.21	0.62^z	0.68^y
Triglycerides, mg/dL	0.25	0.01	0.31	0.20	0.25	0.04	0.34^y	0.15
HDL cholesterol, mg/dL	0	0.7	0.30	0.23	0.20	0.02	0.09	0.06
LDL cholesterol, mg/dL	0.24	0.06	0.24	0.013	0.47^y	0.14	0.46^y	0.31
Total cholesterol, mg/dL	0.23	0.21	0.10	0.43	0.29	0.09	0.36	0.23
Non-HDL, mg/dL	0.18	0.1	0.15	0.30	0.10	0.15	0.20	0.16
AST, U/L	0.09	0.07	0.16	0.01	0.06	0.43	0.02	0.03
ALT, U/L	0.10	0.28	0.07	0.15	0.14	0	0.18	0.05
Gamma-GT	0.41	0.49	0.23	0.07	0.11	0.03	0.013	0.02
Systolic blood pressure, mmHg	0.31	0.37	0.01	0.19	0.34	0.05	0.34	0.49
Diastolic blood pressure, mmHg	0.06	0.35	0.35	0.35	0.88^z	0.19	0.34	0.37
Fasting plasma glucose, mg/dL	0.23	0.45	0.32	0.23	0.14	0.05	0.14	0.07
MetS		0.41^z		0.11		0.21^y		0

ALT = alanine aminotransferase, AST = asparatate transaminase, BMI = body mass index, C = control, GT = gamma glutamyl transferase, HDL-C = high density lipoprotein cholesterol, LDL-C = low density lipoprotein cholesterol, MetS = metabolic syndrome, non-HDL = nonhigh density lipoprotein cholesterol, SCF = subcutaneous fat, VF = visceral fat, WC = waist circumference.

$P < 0.05$.

$^y P < 0.01$.

$^z P < 0.001$.

TABLE 3. Sex-Specific Multivariable-Adjusted Regressions for VF and SCF With Continuous Metabolic Risk Factors (Top) and Dichotomous Risk Factors

	Men				Women			
	VF		SCF		VF		SCF	
	C	MetS	C	MetS	C	MetS	C	MetS
BMI, kg/m^2	0.10	0.13	0.09	0.18	1^y	0.18	0.18	0.36
WC, cm	0.53^z	0.26	0.7^z	0.10	0.44^z	0.4	0.18^z	0.46^y
Triglycerides, mg/dL	0.16^y	0	0.01	0.04	0.12^y	0	0.06	0.02
HDL cholesterol, mg/dL	0.09	0	0.04	0.05	0.05	0	0	0
LDL cholesterol, mg/dL	0	0	0	0.01	0.17^y	0.2	0.05	0.09
Total cholesterol, mg/dL	0.03	0.04	0.01	0.19	0.11	0	0.02	0.05
Non-HDL, mg/dL	0.85	0.17	0.15	0.57	0.47	0.55	0.48	0.42
AST, U/L	0.01	0	0	0	0	0.19	0	0
ALT, U/L	0.13	0.08	0.05	0.2	0.05	0	0.02	0
Gamma-GT	0.32^z	0.24	0.02	0	0	0	0	0
Systolic blood pressure, mmHg	0.28^z	0.13	0.09	0.03	0.42^z	0.26	0.02	0.24
Diastolic blood pressure, mmHg	0.34^z	0.12	0.06	0.12	0.33^y	0.03	0.02	0.14
Fasting plasma glucose, mg/dL	0.02^z	0.21	0.01	0.05	0.08	0	0.01	0
MetS	0.41^z	0.11	0.21^y	0.05				

ALT = alanine aminotransferase, AST = asparatate transaminase, BMI = body mass index, C = control, GGT = gamma glutamyl transferase, HDL-C = high density lipoprotein cholesterol, LDL-C = low density lipoprotein cholesterol, MetS = metabolic syndrome, non-HDL = nonhigh density lipoprotein cholesterol, SCF = subcutaneous fat, VF = visceral fat, WC = waist circumference.

$P < 0.05$.

$^y P < 0.01$.

$^z P < 0.001$.

The proposed mechanism for the increased metabolic risk is the possibility that the metabolically active adipose tissue found in the visceral region of be become dysfunctional, increasing the secretion are substances that alter the metabolic profile and produce chronic inflammation. Several studies have demonstrated that the VF compartment is metabolically active, secreting such vasoactive substances as inflammatory markers, adipocytokines, markers of hemostasis and fibrinolysis and
growth factors which may contribute to its role in cardiometabolic risk factor manifestation.[7,8,25–34]

Our results are consistent with these findings character, community-based sample of men and women in that we show that all cardiometabolic risk factors examined were more strongly associated with VF and SCF.

The Dallas Heart Study, which examined metabolic risk factors relations in 1934 black and white women and men with VF and SCF as assessed by magnetic resonance imaging (MRI) are associated positively with prevalence of hypertension, but only VF provides significant information above and beyond BMI and WC.[35]

Other studies have demonstrated relations between VF and hypertension.[15,16,36–38]

Our results show that both VF are associated positively hypertension, WC and MetS.

In a Japanese study of 973 men who made a computed tomography (CT) to assess VF, a significant association was observed with metabolic risk factors. The incidences of components of metabolic risk factors were significantly higher among individuals with a greater increase in VF ($P < 0.001$). Significant increases the odds ratio for the incidence of high triglycerides and low HDL-C were observed among individuals 50 cm^2 increased VF.[39]

In a study of 607 patients who underwent CT for evaluation of VF. In both men and women, the VF showed significant positive correlations with age, BMI, waist circumference, SCF area, VF area/SCF area (v/s) ratio, systolic blood pressure, blood pressure diastolic blood sugar fasting (FBS), hemoglobin A1c (HbA1c), high density lipoprotein cholesterol (HDLC), triglycerides (TG) and significant negative correlation between the levels of HDLC and adiponectin. The total cholesterol (TC), low density lipoprotein (LDLC), non-HDLC not, can they be correlated with VF in men or women.[40] We also found that both VF and SCF were associated with triglycerides, WC and MetS in women and men.

In another study of 128 Japanese Americans who were followed for a period of 10 to 11 years, who confirmed 57 cases of IGT. IGT significant predictors included VF area (odds ratio [OR] 1 SD increase of 3.82, 95% CI: 1.63–8.94 in fasting plasma glucose [g] at 4.5 mmol/L), HOMA-IR (2.41, 1.15– 5.04), incremental insulin response (IIR) (0.30, 0.13–0.69 PPG at a level of 4.5 mmol/L), by the interactions VF and FPG ($P < 0.003$) and IIR by FPG ($P < 0.03$) after adjustment for age, sex, FPG, and BMI.[11] In our study was seen a significant association VF with impaired glucose tolerance in men with MetS ($P < 0.05$, $r = 0.45$).

Impaired fasting glucose and diabetes, multiple prior studies have demonstrated relations between The VF and pre-diabetic hyperglycemia and diabetes. Although our results show that VF is more highly correlated with MetS than is SCF, VF was an important correlate of the MetS.

Other authors studied 1511 individuals in the MESA (Multi-Ethnic Study of Atherosclerosis) with adiposity assess-ment by CT. A total of 253 participants without MetS at initial scan underwent repeat CT (median interval 3.3 years). Higher VF was associated with cardiometabolic risk and coronary artery calcification, regardless of BMI. VF was more strongly associated with incident MetS than SCF regardless of weight, and was modestly associated with BMI.[41] The new findings in our study was the correlation of ectopic fat with non-HDL cholesterol, liver enzymes, gamma-GT, and Mets.

Strengths and Limitations

This prospective cross-sectional study was limited by its sample size. Strengths of our study include the use of a community-based sample with participants not enriched for adiposity-related traits and high risk for CVD. Routine screen-ing of metabolic risk factors was performed, and adjustment was made for several potential confounders. We used the highly reproducible thickness method of VF and SCF assessment, and which has a high accuracy and reproducibility as compared MRI and CT. Not a multicenter study that could allow a generaliz-ation of the data for other ethnicities.

CONCLUSION

Both VF and SCF are associated with an adverse metabolic risk but, SCF provides better information in women.

REFERENCES

1. Thom T, Haase N, Rosamond W, et al. Heart disease and stroke statistics–2006 update: a report from the American Heart Associa-tion Statistics Committee and Stroke Statistics Subcommittee. Circulation. 2006;113:e85–e151.
2. Fox CS, Evans JC, Larson MG, et al. Temporal trends in coronary heart disease mortality and sudden cardiac death from 1950 to 1999: the Framingham Heart Study. Circulation. 2004;110:522–527.
3. Hu FB, Stampfer MJ, Manson JE, et al. Trends in the incidence of coronary heart disease and changes in diet and lifestyle in women. N Engl J Med. 2000;343:530–537.
4. Flegal KM, Carroll MD, Ogden CL, et al. Prevalence and trends in obesity among US adults, 1999–2000. JAMA. 2002;288: 1723–1727.
5. Ogden CL, Carroll MD, Curtin LR, et al. Prevalence of overweight and obesity in the United States, 1999–2004. JAMA. 2006;295:1549–1555.
6. Klein S. The case of visceral fat: argument for the defense. J Clin Invest. 2004;113:1530–1532.
7. Goodpaster BH, Krishnaswami S, Resnick H, et al. Association between regional adipose tissue distribution and both type 2 diabetes and impaired glucose tolerance in elderly men and women. Diabetes Care. 2003;26:372–379.
8. Kanaya AM, Harris T, Goodpaster BH, et al. Adipocytokines attenuate the association between visceral adiposity and diabetes in older adults Diabetes Care. 2004;27:1375–1380.
9. DeMarco VG, Aroor AR, Sowers JR. The pathophysiology of hypertension in patients with obesity. Nat Rev Endocrinol. 2014;10:364–376.
10. Soo L, James BM. Links between ectopic fat and vascular disease in humans. Arterioscler Thromb Vasc Biol. 2014;34:1820–1826.
11. Boyko EJ, Fujimoto WY, Leonetti DL, et al. Visceral adiposity and risk of type 2 diabetes: a prospective study among Japanese Americans Diabetes Care. 2000;23:465–471.
12. Tulloch-Reid MK, Hanson RL, Sebring NG, et al. Both subcuta-neous and visceral adipose tissue correlate highly with insulin resistance in African Americans. Obes Res. 2004;12:1352–1359.

13. Wagenknecht LE, Langefeld CD, Scherzinger AL, et al. Insulin sensitivity, insulin secretion, and abdominal fat: the Insulin Resis-tance Atherosclerosis Study (IRAS) Family Study. Diabetes. 2003;52:2490–2496.

14. Hayashi T, Boyko EJ, Leonetti DL, et al. Visceral adiposity is an independent predictor of incident hypertension in Japanese Amer-icans. Ann Intern Med. 2004;140:992–1000.

15. Sironi AM, Gastaldelli A, Mari A, et al. Visceral fat in hypertension: influence on insulin resistance and beta-cell function Hypertension. 2004;44:127–133.

16. Ding J, Visser M, Kritchevsky SB, et al. The association of regional fat depots with hypertension in older persons of white and African American ethnicity Am J Hypertens. 2004;17:971–976.

17. Pascot A, Lemieux S, Lemieux I, et al. Age-related increase in visceral adipose tissue and body fat and the metabolic risk profile of premenopausal women. Diabetes Care. 1999;22:1471–1478.

18. Nagaretani H, Nakamura T, Funahashi T, et al. Visceral fat is a major contributor for multiple risk factor clustering in Japanese men with impaired glucose tolerance. Diabetes Care. 2001;24:2127–2133.

19. Nicklas BJ, Penninx BW, Ryan AS, et al. Visceral adipose tissue cutoffs associated with metabolic risk factors for coronary heart disease in women. Diabetes Care. 2003;26:1413–1420.

20. Lemieux S, Prud'homme D, Moorjani S, et al. Do elevated levels of abdominal visceral adipose tissue contribute to age-related differ-ences in plasma lipoprotein concentrations in men? Atherosclerosis. 1995;118:155–164.

21. Kobayashi H, Nakamura T, Miyaoka K, et al. Visceral fat accumula-tion contributes to insulin resistance, small-sized low-density lipo-protein, and progression of coronary artery disease in middle-aged non-obese Japanese men. Jpn Circ J. 2001;65:193–199.

22. Mori Y, Hoshino K, Yokota K, et al. Increased visceral fat and impaired glucose tolerance predict the increased risk of metabolic syndrome in Japanese middle-aged men. Exp Clin Endocrinol Diabetes. 2005;113:334–339.

23. Goodpaster BH, Krishnaswami S, Harris TB, et al. Obesity, regional body fat distribution, and the metabolic syndrome in older men and women. Arch Intern Med. 2005;165:777–783.

24. Carr DB, Utzschneider KM, Hull RL, et al. Intra-abdominal fat is a major determinant of the National Cholesterol Education Program Adult Treatment Panel III criteria for the metabolic syndrome. Diabetes. 2004;53:2087–2094.

25. Hayashi T, Boyko EJ, Leonetti DL, et al. Visceral adiposity and the risk of impaired glucose tolerance: a prospective study among Japanese Americans. Diabetes Care. 2003;26:650–655.

26. Lemieux I, Pascot A, Prud'homme D, et al. Elevated C-reactive protein: another component of the atherothrombotic profile of abdominal obesity. Arterioscler Thromb Vasc Biol. 2001;21:961–967.

27. Azuma K, Katsukawa F, Oguchi S, et al. Correlation between serum resistin level and adiposity in obese individuals. Obes Res. 2003;11:997–1001.

28. Fukuhara A, Matsuda M, Nishizawa M, et al. Visfatin: a protein secreted by visceral fat that mimics the effects of insulin. Science. 2005;307:426–430.

29. Cigolini M, Targher G, Bergamo Andreis I, et al. Visceral fat accumulation and its relation to plasma hemostatic factors in healthy men. Arterioscler Thromb Vasc Biol. 1996;16:368–374.

30. Mertens I, Van Gaal LF. Visceral fat as a determinant of fibrinolysis and hemostasis. Semin Vasc Med. 2005;5:48–55.

31. Miyazawa-Hoshimoto S, Takahashi K, Bujo H, et al. Elevated serum vascular endothelial growth factor is associated with visceral fat accumulation in human obese subjects. Diabetologia. 2003;46:1483– 1488.

32. Giusti V, Suter M, Verdumo C, et al. Molecular determinants of human adipose tissue: differences between visceral and subcutaneous compartments in obese women. J Clin Endocrinol Metab. 2004;89:1379–1384.

33. Nazare JA, Smith J, Borel AL, et al. Usefulness of measuring both body mass index and waist circumference for the estimation of visceral adiposity and related cardiometabolic risk profile (from the INSPIRE ME IAA Study). Am J Cardiol. 2015;115:307–315.

34. Fukuda S, Hirata A, Nishizawa H, et al. Systemic arteriosclerosis and eating behavior in Japanese type 2 diabetic patients with visceral fat accumulation Cardiovasc Diabetol. 2015;14:8.

35. Vega GL, Adams-Huet B, Peshock R, et al. Influence of body fat content and distribution on variation in metabolic risk. J Clin Endocrinol Metab. 2006;91:4459–4466.

36. Hayashi T, Boyko EJ, Leonetti DL, et al. Visceral adiposity is an independent predictor of incident hypertension in Japanese Amer-icans. Ann Intern Med. 2004;140:992–1000.

37. Park YW, Allison DB, Heymsfield SB, et al. Larger amounts of visceral adipose tissue in Asian Americans. Obes Res. 2001;9:381– 387.

38. Hayashi T, Boyko EJ, Leonetti DL, et al. Visceral adiposity and the prevalence of hypertension in Japanese Americans. Circulation. 2003;108:1718–1723.

39. Matsushita Y, Nakagawa T, Yamamoto S, et al. Effect of long-itudinal changes in visceral fat area on incidence of metabolic risk factors: the Hitachi health study. Obesity. 2013;21:2126–2129.

40. Shiina Y, Homma Y. Relationships between the visceral fat area on CT and coronary risk factor markers. Intern Med. 2013;52:1775– 1780.

41. Shah RV, Murthy VL, Abbasi SA, et al. Visceral adiposity and the risk of metabolic syndrome across body mass index: the MESA Study. JACC Cardiovasc Imaging. 2014;7:1221–1235.

Medicine®

OBSERVATIONAL STUDY

Perirenal Fat and Association With Metabolic Risk Factors

The Uberlândia Heart Study

Leonardo Roever, MHS, Elmiro S. Resende, PhD, Fernando C. Veloso, MHS, Angelica L.D. Diniz, PhD, Nilson Penha-Silva, PhD, Antonio Casella-Filho, PhD, Paulo M.M. Dourado, PhD, and Antonio C.P. Chagas, PhD

Abstract: Perirenal fat (PRF) is associated with cardiovascular riskfactors. Gender differences in the correlations of cardiovascular disease risk factors and PRF in the Brazilian population are lacking.

Cross-sectional study with 101 (50.49% men; mean age 56.5 18, range 19–74 years) drawn from the Uberlaˆndia Heart Study underwent ultrasonography assessment of abdominal adipose. For the PRF, a 3.5 MHz transducer was measured in the middle third of the right kidney, with the transducer positioned at the axillary midline. The examinations were always performed by the same examiner. The PRF thickness was examined in relation to waist circumference, blood pressure, and metabolic risk factors. The PRF was significantly associated with the levels of gamma-glutamyl transferase ($P < 0.05$, $r = 0.08$), fasting plasma glucose ($P < 0.05$, $r = 0.07$), waist circumference ($P < 0.05$, $r = 0.10$), and metabolic syndrome ($P < 0.001$, $r = 0.38$) in men, and with the levels of fasting plasma glucose ($P < 0.05$) in women.

The PRF was correlated with most cardiovascular risk factors in men and only in glucose at the women.

(Medicine 94(38):e1105)

Abbreviations: BMI = body mass index, CVD = cardiovascular disease, MetS = metabolic syndrome, PRF = perirenal fat, WC = waist circumference.

INTRODUCTION

Cardiovascular disease (CVD) is the leading cause of mor-bidity and mortality in the world. Visceral fat is a risk factor for multiple CVD risk factors, including hypertension, dyslipidemia, diabetes, and the metabolic syndrome (MetS).[1–5] In a systematic analysis of epidemiological studies carried out in 199 countries, it was revealed that about 1.46 billion adults were overweight, and of these 502 million were obese.[6] Abdominal obesity is closely associated with hyperten-sion, insulin resistance, type 2 diabetes, dyslipidemia, abnormal secretion of adipokines, and CVD. Obesity is the central role of the MetS, which further includes renovascular risk factors such as endothelial dysfunction, albuminuria, dyslipidemia, hyper-tension, and glucose disturbances.[7–12]

The accumulated perirenal fat (PRF) on the kidneys and firmly encapsulating them can damage kidney function.[13,14]

The aim of this study was to analyze the association among PRF and other obesity-related parameters, such as waist cir-cumference (WC), blood pressure and metabolic risk factors.

METHODS

Study Sample

Cross-sectional study with 101 volunteers (50.49% men; mean age 56.5 18, range 19–74 years) drawn from the Uberlaˆndia Heart Study underwent ultrasonography assessment of abdominal adipose tissue. The study was approved by the institutional review boards of the Federal University of Uber-laˆndia. All subjects provided written informed consent.

Abdominal Adipose Tissue Measurements

A Versa Pro (Siemens; Erlangen, Germany) ultrasound equipment with transducer of 3.5 MHz was used to measure the PRF thickness. The patient was positioned in dorsal decu-bitus, and the transducer was positioned at the axillary midline in the longitudinal plain (Fig. 1). Then the image of the right kidney and perirenal area was observed, with posterior measurement of the lateral hipoecoic area that matches to the PRF in millimeters. The examinations were always performed by the same examiner. Due to method validation in a previous study, we chose the right PRF. Patients with difficulties in obtaining images (meteorism, renal parenchymal anomalies) were excluded.

Risk Factor and Covariate Assessment

Risk factors and covariates were measured at the exam-ination. Body mass index, defined as weight (in kilograms) divided by the square of height (in meters), was measured at each index examination. WC was measured at the level of the umbilicus. Fasting plasma glucose and lipid profile were measured on fasting morning samples. Diabetes was defined as a fasting plasma glucose level 126 mg/dL. Impaired fasting glucose was defined as a fasting plasma glucose level of 100 to 125 mg/dL among those not treated for diabetes. Hypertension was defined as systolic blood pressure 135 mm Hg, diastolic blood pressure 85 mm Hg, or on treatment. MetS was defined from modified Adult Treatment Panel criteria.

Statistical Analysis

PRF was normally distributed. Sex-specific age-adjusted Pearson correlation coefficients were used to assess simple correlations between PRF and metabolic risk factors.

Editor: Leonardo Gilardi.
Received: April 29, 2015; revised: June 5, 2015; accepted: June 1, 2015.
From the Federal University of Uberlaˆndia (LR, ESR, FCV, ALDD, NPS); Heart Institute (InCor), HCFMUSP, University of Saˆo Paulo Medical School, Saˆo Paulo (ACF, PMMD, ACPC); and Faculty of Medicine ABC, Santo Andre´, Brazil (ACPC).
Correspondence: Dr. Leonardo Roever, Department of Clinical Research, Av Para´, 1720, Bairro Umuarama, Uberlaˆndia, CEP: 38400-902, MG, Brazil (e-mail: leonardoroever@hotmail.com).
This research was supported by the Federal University of Uberlaˆndia.
The authors have no conflicts of interest to disclose.

ISSN: 0025-7974
DOI: 10.1097/MD.0000000000001105

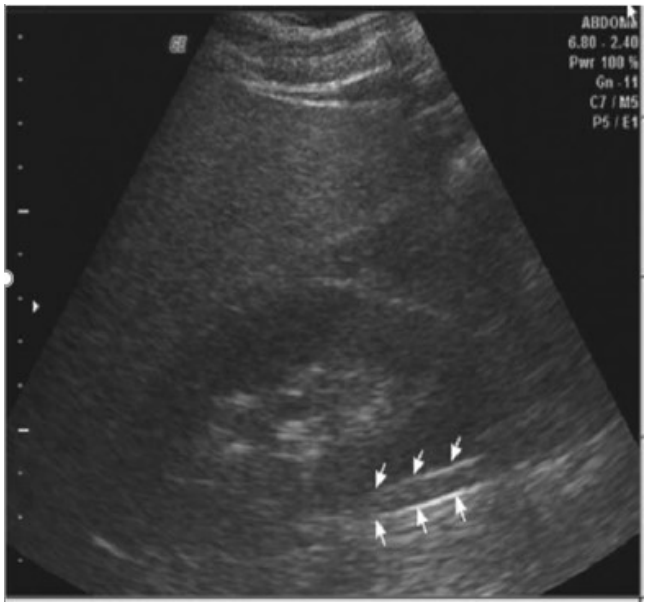

FIGURE 1.The thickness of perirenal fat

Multivariable linear and logistic regression was used to assess the significance of covariate-adjusted cross-sectional relations between continuous and dichotomous metabolic risk factors and PRF. A P

value of 0.05 was considered to indicate significance. SPSS Version 21 software (SPSS, Chicago, IL) was used.

RESULTS

Baseline Characteristics

Overall, 49 women and 52 men were available for analysis. The mean age of the study sample was 48 for women and 52 for men, and 48.5% were women (Tables 1–3); 40.2% were hypertensive, 39.3% had obese, 61.8% abdominal obesity, 32% hypertriglyceridemia, 33.2% low high-density lipoprotein cholesterol and high low-density lipoprotein cholesterol, 40.2 % high total cholesterol, 33.2% high non–high-density lipoprotein cholesterol, 22.7 % mixed dyslipidemia, 20.2% impaired fast-ing glucose, and 41.1% had MetS (Figures 2–4). Mean PRF fat thickness was 0.2 cm in both women and men.

DISCUSSION

In the present study, we found the association of PRF with the levels of gamma-glutamyl transferase (GT), fasting plasma,

TABLE 1. Study Sample Characteristics

	Men (52)	Women (49)
Age	52 (13)	48 (6.4)
BMI, kg/m^2	25.9 (4.1)	26.3 (3.4)
Overweight (BMI 25 and 30), %	26.9	26.5
Obesity grade 1(BMI 30and 35), %	7.6	18.3
WC, cm	96.2(11.9)	85.2(10.9)
WC 94 cm man and 80 cm woman, %	55.7	69.3
Triglycerides, mg/dL	167.6(39–638)	123.8(44–490)
Hypertriglyceridemia 150 mg/dL, %	40.3	24.4
HDL cholesterol, mg/dL	45.7(11.7)	52.2(11.2)
HDL 40 man and 50 women, mg/dL, %	34.6	32.6
LDL cholesterol, mg/dL	115(28.4)	119.7(39.4)
LDL cholesterol, mg/dL, 130, %	34.6	32.6
Total cholesterol, mg/dL	191.3(38.4)	196.2(40.3)
Total cholesterol mg/dL 200, %	36.5	44.8
Non-HDL, mg/dL	140.6(35.7)	141.9(42)
Non-HDL 160 men and 150 women, mg/dL, %	32.6	34.6
Mixed dyslipidemia, %	13.4	32.6
AST, U/L	17.2(7.8)	12.9(2.9)
ALT, U/L	40.3(23.3)	25.2((11)
GGT	43.7(34.4)	25.2(17.1)
Systolic blood pressure, mm Hg	126.4(15.4)	121.3(16,8)
Diastolic blood pressure, mm Hg	84.8(9.5)	81.5(9.7)
Hypertension, %	48.7	32.6
Fasting plasma glucose, mg/dL	96.3(10.8)	90.8(10.8)
Impaired fasting glucose, %	28.8	12.2
MetS, %	38.4	44.8
Postmenopausal, %	36.7	. . .
Hormone replacement therapy, %	34.6	. . .
PRF, cm	0.2(0.8)	0.27(1)

ALT = alanine aminotransferase, AST = aspartate transaminase, BMI = body mass index, GGT = gamma-glutamyl transferase, HDL-C = high-density lipoprotein cholesterol, LDL-C = low-density lipoprotein cholesterol, MetS = metabolic syndrome, PRF = perirenal fat, WC = waist circumference.

TABLE 2. Sex-Adjusted Pearson Correlation Coefficients between Metabolic Risk Factors and PRF Thickness

	PRF			
	Men		Women	
	Control	MetS	Control	MetS
BMI, kg/m^2	0.28	0.13	0.09	0.13
WC, cm	0.05	0.23	0.02	0.013
Triglycerides, mg/dL	0.17	0.37	0.32	0.02
HDL cholesterol, mg/dL	0.4	0.25	0	0,28
LDL cholesterol, mg/dL	0.22	0.41	0.19	0.04
Total cholesterol, mg/dL	0.05	0.24	0.32	0.02
Non-HDL, mg/dL	0.6	0.20	0.32	0.7
AST, U/L	0.12	0.13	0.18	0.09
ALT, U/L	0.24	0.17	0.08	0.24
GGT	0.18	0.47	0.19	0.45
Systolic blood pressure, mm Hg	0.18	0.23	0.14	0.34
Diastolic blood pressure, mm Hg	0.12	0.18	0.28	0.14
Fasting plasma glucose, mg/dL	0.12	0.27	0.6	0.47
MetS	0.38		0	

ALT = alanine aminotransferase, AST = aspartate transaminase, BMI = body mass index, GGT = gamma-glutamyl transferase, HDL-C = high-density lipoprotein cholesterol, LDL-C = low-density lipoprotein cholesterol, MetS = metabolic syndrome, PRF = perirenal fat, WC = waist circumference.

P < 0.05. P < 0.01. P < 0.001.

TABLE 3. Sex-Specific Multivariable-Adjusted Regressions for PRF With Continuous Metabolic Risk Factors (Top) and Dichotomous Risk Factors

	Men		Women	
	Control	MetS	Control	MetS
BMI, kg/m^2	0.15	0.50	0.44	0.16
WC, cm	0.10	0.05	0	0.01
Triglycerides, mg/dL	0	0.14	0.01	0.04
HDL cholesterol, mg/dL	0.01	0.06	0.02	0.08
LDL cholesterol, mg/dL	0.02	0.17	0	0
Total cholesterol, mg/dL	0.01	0.05	0.03	0
Non-HDL, mg/dL	0.38	0.78	0.17	0.12
AST, U/L	0	0.01	0.01	0
ALT, U/L	0.02	0.03	0.01	0.06
GGT	0.08	0.22	0.03	0.21
Systolic blood pressure, mm Hg	0.06	0.03	0	0.11
Diastolic blood pressure, mm Hg	0.03	0.05	0	0.02
Fasting plasma glucose, mg/dL MetS	0.07	0.07	0.08	0.22
	0.14		0	

ALT = alanine aminotransferase, AST = aspartate transaminase, BMI = body mass index, GGT = gamma-glutamyl transferase, HDL-C = high density lipoprotein cholesterol, LDL-C = low density lipopro-tein cholesterol, MetS = Metabolic syndrome, PRF = perirenal fat, WC = waist circumference.

P < 0.05.

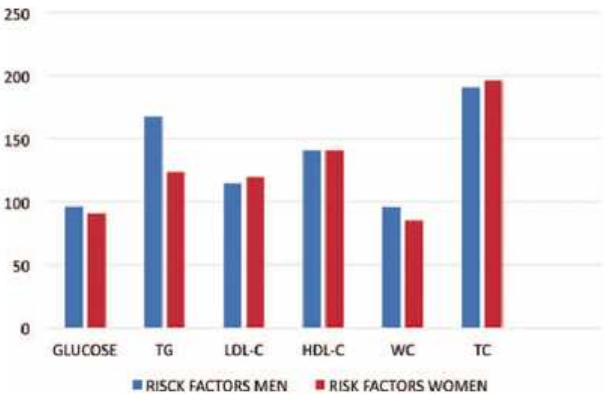

FIGURE 2. Prevalence (%) in men and women.

WC, and MetS in men, and with the levels of fasting plasma glucose in women.

The visceral fat accumulation is a major determinant of increased risks for cardiovascular and metabolic diseases.[15,16]

The perirenal ultrasonographic fat thickness measurement may better reflect the risks commonly associated with increased visceral fat accumulation and particularly those related to renal function impairment, microalbuminuria, hypertension, and uricemia. The perirenal adipose tissue has been shown to compress renal vessels and renal parenchyma, causing elevated renal interstitial hydrostatic fluid, and reductions in both renal blood and tubular flow rate.[17–20]

Among the mechanisms proposed to explain the association between visceral obesity with hypertension, we found an increase in sodium reabsorption and sympathetic activity in obese patients.[21–28]

In others studies, the renal sinus fat accumulations displaces and compresses the renal veins and lymphatic vessels, as well as compress the ureters causing an increase in hydrostatic pressure and renal activation of the renin–angiotensin–aldosterone system causing hypertension resistant insulin, atherosclerosis.[29–32]

The thickness of the PRF may indicate individuals who have an increased atherosclerotic disease development potential.

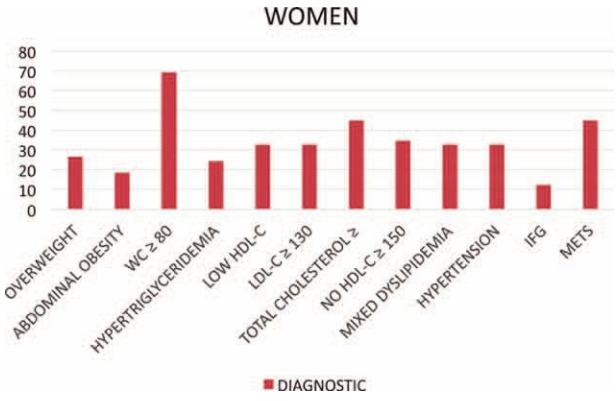

FIGURE 3. Risk factors in women

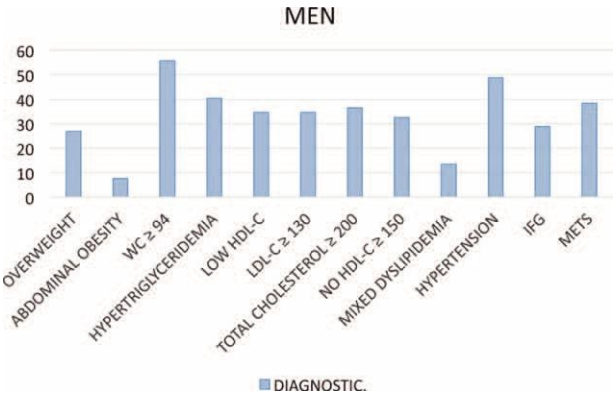

FIGURE 4. Risk factors in men.

STRENGTHS AND LIMITATIONS

This is not a multicenter study.

Novelty and Significance.

What is new is that the thickness of abdominal fat was correlated with cardiovascular risk factors in humans. Among the main factors in the correlation was positive in men with WC, gamma-GT, fasting plasma glucose, and MetS in men, and with the levels of fasting plasma glucose in women. The PRF is associated with cardiovascular risk factors.

CONCLUSION

The PRF is associated with an adverse metabolic risk profile.

REFERENCES

1. Thom T, Haase N, Rosamond W, et al., American Heart Association Statistics Committee and Stroke Statistics Subcommittee. Heart disease and stroke statistics: 2006 update—a report from the American Heart Association Statistics Committee and Stroke Statis-tics Subcommittee. Circulation. 2006;113:e85e151.
2. Fox CS, Evans JC, Larson MG, et al. Temporal trends in coronary heart disease mortality and sudden cardiac death from 1950 to 1999: the Framingham Heart Study. Circulation. 2004;110:522–527.
3. Hu FB, Stampfer MJ, Manson JE, et al. Trends in the incidence of coronary heart disease and changes in diet and lifestyle in women. N Engl J Med. 2000;343:530–537.
4. Flegal KM, Carroll MD, Ogden CL, et al. Prevalence and trends in obesity among US adults, 1999–2000. JAMA. 2002;288:1723–1727.
5. Ogden CL, Carroll MD, Curtin LR, et al. Prevalence of overweight and obesity in the United States, 1999-2004. JAMA. 2006;295: 1549–1555.
6. Finucane MM, Stevens GA, Cowan MJ, et al. National, regional, and global trends in body-mass index since 1980: systematic analysis of health examination surveys and epidemiological studies with 960 country-years and 9.1 million participants. Lancet. 2011;377: 557–567.
7. Hall JE, da Silva AA, do Carmo JM, et al. Obesity-induced hypertension: role of sympathetic nervous system, leptin, and melanocortins. J Biol Chem. 2010;285:17271.
8. Dixon] JB. The effect of obesity on health outcomes. Mol Cell Endocrinol. 2010;316:104–108
9. Wang Y, Beydoun MA, Liang L, et al. Will all Americans become overweight or obese? Estimating the progression and cost of the US obesity epidemic. Obesity. 2008;16:2323–2330.
10 Hayashi T, Boyko EJ, McNeely MJ, et al. Visceral adiposity, not abdominal subcutaneous fat area, is associated with an increase in future insulin resistance in Japanese Americans. Diabetes. 2008;57:1269.
11. Ohman MK, Shen Y, Obimba CI, et al. Visceral adipose tissue inflammation accelerates atherosclerosis in apolipoprotein e-deficient mice. Circulation. 2008;117:798–805.
12. Dolinkova M, Dostalova I, Lacinova Z, et al. The endocrine profile of subcutaneous and visceral adipose tissue of obese patients. Mol Cell Endocrinol. 2008;291:63–70.
13. Lamacchia O, Nicastro V, Camarchio D, et al. Para-and perirenal fat thickness is an independent predictor of chronic kidney disease, increased renal resistance index and hyperuricaemia in type-2 diabetic patients. Nephrol Dial Transplant. 2011;26:892.
14. Li Z, Woollard JR, Wang S, et al. Increased glomerular filtration rate in early metabolic syndrome is associated with renal adiposity and microvascular proliferation. Am J Physiol Renal Physiol. 2011;301:F1078–F1087.
15. Pou KM, Massaro JM, Hoffmann U, et al. Visceral and subcuta-neous adipose tissue volumes are cross-sectionally related to markers of inflammation and oxidative stress. Circulation. 2007;116:1234–1241.
16. Karunakaran I, Mohan AR, Jayagaopi S, et al. Association of visceral and subcutaneous fat with glucose intolerance, insulin resistance, adipocytokines and inflammatory markers in Asian Indians (CURES-113) Clin Biochem. 2011;44:281–287.
17. Kawasaki S, Aoki K, Hasegawa O, et al. Sonographic evaluation of visceral fat by measuring para- and perirenal fat. J Clin Ultrasound. 2008;36:129–133.
18. Rea DJ, Heimbach JK, Grande JP, et al. Glomerular volume and renal histology in obese and non-obese living kidney donors. Kidney Int. 2006;70:1636–1641.
19. Li Z, Woollard JR, Wang S, et al. Increased glomerular filtration rate in early metabolic syndrome is associated with renal adiposity and microvascular proliferation. Am J Physiol Renal Physiol. 2011;301:F1078–F1087.
20. Chughtai HL, Morgan TM, Rocco M, et al. Renal sinus fat and poor blood pressure control in middle-aged and elderly individuals at risk for cardiovascular events. Hypertension. 2010;56:901–906.
21. Kaplan NM. The Deadly Quartet. Upper-body obesity, glucose intolerance, hypertriglyceridemia, and hypertension. Arch Intern Med. 1989;149:1514–1520.
22. Boyko EJ, Leonetti DL, Bergstrom RW, et al. Visceral adiposity, fasting plasma insulin, and blood pressure in Japanese-Americans. Diabetes Care. 1995;18:174.
23. Kanai H, Matsuzawa Y, Kotani K, et al. Close correlation of intra-abdominal fat accumulation to hypertension in obese women. Hypertension. 1990;16:484–490.
24. Landsberg L. Hyperinsulinemia: possible role in obesity-induced hypertension. Hypertension. 1992;19:I-61–I-66.
25. DeFronzo RA. Insulin and renal sodium handling: clinical implica-tions. Int J Obesity. 1981;5:93–104.
26. Sironi AM, Pingitore A, Ghione S, et al. Early hypertension is associated with reduced regional cardiac function, insulin resistance, epicardial, and visceral fat. Hypertension. 2008;51:282–288.
27. Filho RF, Faria A, Kohlmann O, et al. Ultrasonography for the evaluation of visceral fat and cardiovascular risk. Hypertension. 2001;38:713–717

28. Mathieu P, Poirier P, Pibarot P, et al. Visceral obesity: the link among inflammation hypertension and cardiovascular disease. Hypertension. 2009;53:577-584.
29. BjörntorpP. Portal adipose tissue as a generator of risk factors for cardiovascular disease and diabetes. Arteriosclerosis. 1990;10:493–494
30.Bray GA, Gray DS. Treatment of obesity: an overview. Diabetes Metab. 1988;4:653–679.
31. Chughtai HL, Morgan TM, Michael Rocco M, et al. Renal sinus fat and poor blood pressure control in middle-aged and elderly individuals at risk for cardiovascular events. Hypertension. 2010;56:901–906.
32. Vries APJ, Piero P, Ruan ZX, et al. Fatty kidney: emerging role of ectopic lipid in obesity-related renal Disease. Lancet Diabetes Endocrinol. 2014;2:417–426.

International Journal of Cardiology 190 (2015) 140–142

Contents lists available at ScienceDirect

International Journal of Cardiology

journal homepage: www.elsevier.com/locate/ijcard

Letter to the editor

Ectopic adiposopathy and association with cardiovascular disease risk factors: The Uberlândia Heart Study

L. Roever[a,*], E.S. Resende[a], A.L.D. Diniz[a], N. Penha-Silva[a], F.C. Veloso[a], A. Casella-Filho[b], P.M.M. Dourado[b], A.C.P. Chagas[b,c]

[a] Federal University of Uberlândia, Brazil
[b] Heart Institute (InCor), HCFMUSP — University of São Paulo Medical School, São Paulo, Brazil
[c] Faculty of Medicine ABC, Santo André, Brazil

ARTICLE INFO

Article history:
Received 18 April 2015
Accepted 20 April 2015
Available online 23 April 2015

Keywords: Ectopic fat Cardiometabolic risk profile
Ultrasonography
Metabolic syndrome

Cardiovascular disease (CVD) is the leading cause of morbidity and mortality in the world. Ectopic fat is a risk factor for multiple CVD risk factors, including hypertension, dyslipidemia, diabetes, and the metabolic syndrome (MetS) [1.3]. Visceral fat has been termed an endocrine organ, in part because it secretes adipocytokines and other vasoactive substances that can influence the risk of developing metabolic traits [4,5].

This prospective cross-sectional study with 101 volunteers (50.49% men; mean age 56.5 ± 18, range 19.74 years) drawn rom the Uberlândia Heart Study underwent ultrasonography assessment of abdominal adipose tissue. The study was approved by the institutional review boards of the Federal University of Uberlândia. All subjects provided written informed consent.

The ultrasound exam was performed always by the same examiner with an equipment Versa-Pro (Siemens; Erlangen, Germany), using the preset for abdominal exam. The assessment of abdominal visceral adipose tissue was done with a convex transducer of 3.5 MHz of frequency. The thickness of visceral fat was ultrasonographically measured by the distance between the inner face of the abdominal muscle and the posterior face of the abdominal aorta, 1 cm above the umbilicus (Fig. 1). The subcutaneous fat thickness (Fig. 2) was measured with a 7.5 MHz linear transducer transversely positioned 1 cm above the umbilical scar.

* Corresponding author at: Department of Clinical Research, Leonardo S. Roever-Borges, MHS, Av. Pará, 1720 — Bairro Umuarama Uberlândia, MG CEP 38400-902, Brazil.
E-mail address: leonardoroever@hotmail.com (L. Roever).

http://dx.doi.org/10.1016/j.ijcard.2015.04.170
0167-5273/

Overall, 49 women (W) and 52 men (M) were available for analysis. The mean age of the study sample was 48 W and 52 M years, and 48.5% were women (Table 1). Correlations of VF and SCF with metabolic risk factors are shown in Table 2.

In the Uberlândia Heart Study, thickness US measures of both VF and SCF were correlated with multiple metabolic risk factors, although risk factor correlations with VF were consistently significantly stronger than those for SCF. VF was more strongly associated with metabolic risk factors in men than in women after multivariable-adjusted regressions. SCF was more strongly associated with metabolic risk factors in women than in men after correlation.

Several studies have demonstrated that the visceral fat compartment is metabolically active, secreting such vasoactive substances as inflammatory markers, adipocytokines, markers of hemostasis and fibrinolysis and growth factors which may contribute to its role in cardiometabolic risk factor manifestation [6,7].

In the Dallas Heart Study which examined metabolic risk factors relations in 1934 black and white women and men with VF and SCF as assessed by MRI are associated positively with prevalence of

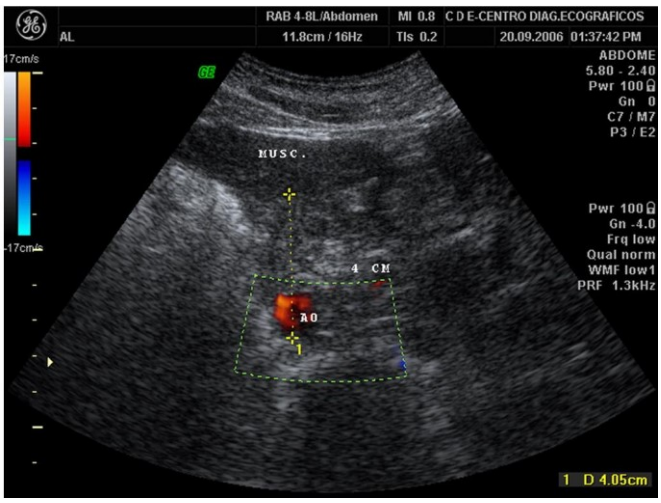

Fig. 1. The thickness of visceral fat

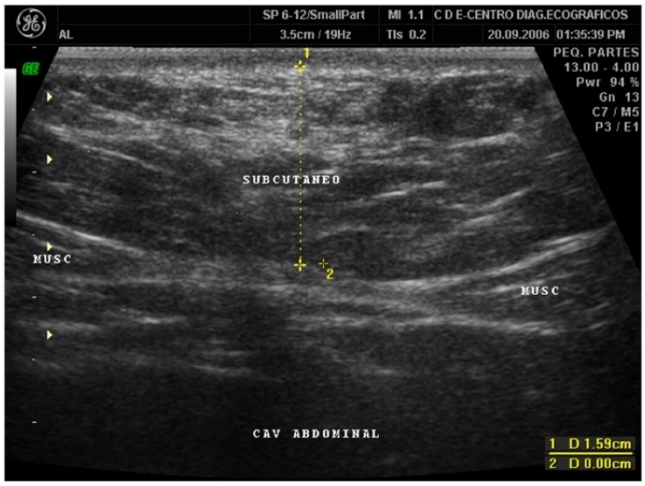

Fig.2.Thethicknessofsubcutaneousfat.

hypertension,butonlyVFprovidessignificantinformationaboveand beyondBMIandWC[8].

InaJapanesestudyof973menwhounderwentcomputedtomography(CT)toassessVF,asignificantassociationwasobservedwith metabolicriskfactors.Theincidencesofcomponentsofmetabolicrisk factorsweresignificantlyhigheramongindividualswithagreater increaseinVF(Pb0.001).Significantincreasesintheoddsratiofor theincidenceofhightriglyceridesandlowHDL-Cwereobserved amongindividualswith≥50cm^{2}increasedVF[9,10].

Inastudyof607patientswhounderwentcomputedtomography (CT)forevaluationofVF.Inbothmenandwomen,theVFshowedsignificantpositivecorrelationswithage,BMI,waistcircumference,subcutaneousfatarea,visceralfatarea/subcutaneousfatarea(v/s)ratio, systolicbloodpressure,diastolicbloodpressure,fastingblood sugar

Table1
Studysamplecharacteristics

	Men(52)	Women(49)
Age, y	52 (13)	48 (6.4)
BMI, kg/m2	25.9 (4.1)	26.3 (3.4)
Overweight (BMI ≥25 and ≥30), %	26.9	26.5
Obesity grade 1 (BMI ≥30 and ≥35), %	7.6	18.3
WC, cm	96.2 (11.9)	85.2 (10.9)
WC ≥94 M andW80 cm, %	55.7	69.3
Triglycerides, mg/dL	167.6 (39–638)	123.8 (44–490)
Hypertriglyceridemia ≥150 mg/dL, %	40.3	24.4
HDL cholesterol, mg/dL	45.7 (11.7)	52.2 (11.2)
HDL ≤40 M and 50 W(mg/dL) %	34.6	32.6
LDL cholesterol, mg/dL	115 (28.4)	119.7 (39.4)
LDL cholesterol, ≥130 mg/dL, %	34.6	32.6
Total cholesterol, mg/dL	191.3 (38.4)	196.2 (40.3)
Total cholesterol, ≥200 mg/dL, %	36.5	44.8
Non-HDL-C, mg/dL	140.6 (35.7)	141.9 (42)
Non-HDL-C, ≥160 M and 150 W(mg/dL), %	32.6	34.6
Mixed dyslipidemia, %	13.4	32.6
AST, U/L	17.2 (7.8)	12.9 (2.9)
ALT, U/L	40.3 (23.3)	25.2 (11)
Gamma-GT, U/L	L 43.7 (34.4)	25.2 (17.1)
Systolic blood pressure, mm Hg	126.4 (15.4)	121.3 (16.8)
Diastolic blood pressure, mm Hg	84.8 (9.5)	81.5 (9.7)
Hypertension, %	48.7	32.6
Fasting plasma glucose, mg/dL	96.3 (10.8)	90.8 (10.8)
Impaired fasting glucose, %	28.8	12.2
MetS, %	38.4	44.8
Postmenopausal, %	36.7	...
Hormone replacement therapy, %	34.6	...
SAT, cm	2 (0.8)	2.7 (1)
VF, cm	6.8 (2)	4.9 (1.6)

Data are presented as mean ± SD when appropriate. M (men) andW(women).

Table 2
Sex-adjustedPearsoncorrelationcoefficientsbetweenmetabolicriskfactorsandVFandSCFthickness.

	Men				Women			
	VF		SCF		VF		SCF	
	C	MetS	C	MetS	C	MetS	C	MetS
BMI, kg/m^2	0.18	-0.32	0.11	0.41	0.49‡	0	0.39□	0.13
WC, cm	0.67	0.51	0.65	0.32	0.66‡	0.21	0.62‡	0.68†
Triglycerides, mg/dL HDL	0.25	0.01	0.31	−0.20	0.25	−0.04	0.34†	0.15
cholesterol, mg/dL LDL	0	0.7	-0.30	0.23	−0.20	0.02	−0.09	0.06
cholesterol, mg/dL Total	0.24	-0.06	0.24	−0.013	0.47†	0.14	0.46†	−0.31
cholesterol, mg/dL Non-	0.23	0.21	0.10	−0.43□	0.29	0.09	0.36□	−0.23
HDL, mg/dL	0.18	-0.1	-0.15	0.30	0.10	0.15	0.20	−0.16
AST, U/L ALT,	0.09	0.07	0.16	0.01	−0.06	0.43	0.02	0.03
U/L	0.10	0.28	0.07	0.15	0.14	0	0.18	0.05
Gamma-GT	0.41*	0.49	0.23	−0.07	0.11	−0.03	−0.013	0.02
Systolic blood pressure, mm Hg	0.31	0.37	-0.01	0.19	0.34□	0.05□	0.34□	0.49
Diastolic blood pressure, mm Hg	0.06	0.35	0.35	0.35	0.88‡	0.19	0.34□	0.37
Fasting plasma glucose, mg/dL	0.23	0.41	0.32	−0.23	0.14	0.05	0.14	−0.07
MetS	0.41		0.11*		0.21†		0	

C—control,MetS—metabolicsyndrome.
□ P b0.05.
† P b0.01.
‡ P b 0.001.

1- Conclusões

A US abdominal é um método válido e facilmente reprodutível para avaliação da espessura da gordura visceral (GV), subcutânea (GSC) e perirrenal(GPR).

Estas medidas permitem identificar depósitos ectópicos de gordura que estão associadas ao risco metabólico adverso. A GSCapresentou correlação positiva com a circunferência abdominalnas mulheres e nos homens. Também houve correlação positiva com a pressão arterial sistólica e com a presença de síndrome metabólica nos homens. Agordura perirrenal está associada a um perfil de risco metabólico adverso e foram encontradas associações com os níveis mais elevados de gamma-glutaryl transferase (ɤGT), glicemia de jejum,circunferência abdominal e maior prevalência de síndrome metabólica em homens. Nas mulheres encontrou-se níveis mais elevados de glicemia de jejum.

.

Referências

1. SAMAD, F., VYSAL, K.T., WIESBROCK, S.M., PANDEY, M. Tumor necrosis factor alpha is a key component in the obesity - linked eleveation of plasminogen activator inhibitor 1. Proc natl Acad Sci, https://doi.org/10.1073/pnas.96.12.6902

2. HANSEN, B.C. The metabolic syndrome X. Ann N.Y. Acad Sci, 892:1-24,1999. https://doi.org/10.1111/j.1749-6632.1999.tb07782.x

https://doi.org/10.1111/j.1749-6632.1999.tb07782.x
https://doi.org/10.1111/j.1749-6632.1999.tb07782.x

3. DUNCAN, B.B., SCHMIDT. M.A. Chronic activation of the innate immune system may underlie the metabolic syndrome. Sao Paulo, Med Journal, 119(3):122-7,2001. https://doi.org/10.1590/S1516-31802001000300008

4. REAVEN,G. Role of insulin resistance in human disease. Diabetes, 37:1595- https://doi.org/10.2337/diab.37.12.1595

5. ZAVARONI, I.; BONORA, E.; PAGLIARA, M. Risk factors for coronary artery disease in healthy persons with hyperinsulinemia and normal glucosa tolerance. N Engl J Med, 320:702-706,1989. https://doi.org/10.1056/NEJM198903163201105

6. LAKKA HM, LAAKSONEN DE, LAKKA TA, NISKANEM LK, KUMPUSALO E, TUOMILEHTO J. The metabolic syndrome and total and cardiovascular disease mortality in middle-aged men. JAMA, v. 288, p. 2709- 2716,2002. https://doi.org/10.1001/jama.288.21.2709

7. FORD ES, GILES WH. A comparison of the prevalence of the metabolic syndrome using two proposed definitions. Diabetes Care, v. 26, p. 575-581, 2003. https://doi.org/10.2337/diacare.26.3.575

8. HAFFNER S, TAEGTMEYER H. Epidemic obesity and the metabolicsyndrome. Circulation, v. 108, p. 1541-1545, 2003. https://doi.org/10.1161/01.CIR.0000088845.17586.EC

9. GANG H, QIAO Q, TUOMILEHTO J, BALKAU B, BORCH-JOHNSEN K, PYORALA K. Prevalence of the metabolic syndrome and its relation to all-cause and cardiovascular mortality in nondiabetic European men in women. Arch Intern Med, v. 164, p. 1066-1076,2004. https://doi.org/10.1001/archinte.164.10.1066

10. GIRMAN CJ, RHODES T, MERCURI M, PYÖRÄLÄ K, KJEKSHUS J, PEDERSEN TR. The metabolic syndrome and risk of major coronary events in the Scandinavian Simvastatin Survival Study (4S) and the Air Force/Texas Coronary

Atherosclerosis Prevention Study (AFCAPS/TexCAPS). Am J Cardiol, v. 93, p. 136-141,2004.
https://doi.org/10.1016/j.amjcard.2003.09.028

11. FONSECA-ALANIZ, MIRIAM H. O tecido adiposo como centro regulador do metabolismo. Arq Bras Endocrinol Metab, Abr, vol.50, no.2, p.216-229,2006.
https://doi.org/10.1590/S0004-27302006000200008

12. ORGANIZAÇÃO MUNDIAL DE SAÚDE. WHO CONSULTATION: Definition, diagnosis and classification of diabetes mellitus and itscomplications. WHO/NCD/NCS/99.2;31-33.

13. MAISON, P., BYRNE, C.D., HALES, C.N., DAY, N.E., WAREHAM, N.J. Do different dimensions of the metabolic syndrome change together over time. Diab Care,24:1758-63,2001.
https://doi.org/10.2337/diacare.24.10.1758

14. ASCHNER, P. Conceito e epidemiologia da síndrome metabólica. In: Curso latino-americano sobre diabetes e síndrome metabólica para clínicos.2003:7.

15. AGUILAR-SALINAS CA, ROJAS R, GÓMEZ-PEREZ FJ, VALLES V, RIOS-TORRES JM, FRANCO A. High prevalence of metabolic syndrome in Mexico. Arch Med Res, v. 35, p. 76-81,2004.
https://doi.org/10.1016/j.arcmed.2003.06.006

16. OH J-Y, HONG YS, SUNG Y-A, CONNOR-BARRETT E. Prevalence and factor analysis of metabolic syndrome in an urban Korean population. Diabetes Care, v. 27, p. 2027-2032,2004.
https://doi.org/10.2337/diacare.27.8.2027

17. ALBERTI FGMM, ZIMMET PZ. Definition, diagnosis and classification of diabetes mellitus and its complications. Part 1: Diagnosis and classification of diabetes mellitus, provisional report of a WHO consultation. Diabet Med, v. 15, p. 539-553,1998.https://doi.org/10.1002/(SICI)1096-9136(199807)15:7<539::AID-DIA668>3.0.CO;2-S

18. EXPERT PANEL ON DETECTION, EVALUATION AND TREATMENT OF HIGH BLOOD CHOLESTEROL IN ADULTS. Executive summary of the Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation and Treatment of High Cholesterol. JAMA, v. 285, p. 2486-2497,2001.
https://doi.org/10.1001/jama.285.19.2486

19. FORD. EJ., GILES WH. A comparison of the of the prevalence of methabolic syndrome using two proposed definition. Diabetes care, v. 26,p. 575-581,2003.
https://doi.org/10.2337/diacare.26.3.575

20. OLIVEIRA, ERNESTO P. DE, SOUZA, MIRABEAU LEVI A. DE AND LIMA, MARIA DAS DORES A. de Prevalência de síndrome metabólica em uma área rural do semi-árido baiano. Arq Bras Endocrinol Metab, vol.50, no.3, p.456- 465,2006. https://doi.org/10.1590/S0004-27302006000300008

21. SOCIEDADE BRASILEIRA DE CARDIOLOGIA. I Diretriz brasileira de Diagnóstico e tratamento da Síndrome Metabólica, São Paulo,2005.

22. DIRETRIZES DA SOCIEDADE BRASILEIRA DE DIABETES.https://www.diabetes.org.br/profissionais/images/2017/diretrizes/diretrizes-sbd-2017-2018.pdf

23. GORTMAKER SL, PETERSON K, WIECHA J. Reducing obesity via a school-based interdisciplinary intervention among youth. Arch Ped Adolesc Med, v. 153, p.409-418.
https://doi.org/10.1001/archpedi.153.4.409

24. LAKKA TA, LAAKSONEN DE. Physical activity in prevention and treatment of the metabolic syndrome.Appl Physiol Nutr Metab. 32(1):76-88,2007.
https://doi.org/10.1139/h06-113

25. JM, RODRIGUEZ C, HEATH JR CW. Body-mass index and mortality in a prospective cohort of US adults. N Engl J Med, v. 341, p. 1097-1105,1999.
https://doi.org/10.1056/NEJM199910073411501

26. Huper L, Summerbell CD, Higgins JPT, Thompson RL, Capps ME, Smith GE et al. Dietary fatty intake and prevention of cardiovascular disease: systematic review. BMJ, v. 322, p. 757-763,2001.
https://doi.org/10.1136/bmj.322.7289.757

27. OOMEN CM, OCKE MC, FESKENS EJM, VANERP-BAART MA, KOK FJ, KROMHOU T. Association between trans fatty acid intake and ten-year risk of coronary disease in the Zutphen Elderly Study: a prospective population-based study. Lancet, v. 357, p.746-751,2001.
https://doi.org/10.1016/S0140-6736(00)04166-0

28. SINGH RB, DUBNOV G, NIAZ MA, GHOSH S, SINGH R, RASTOGI SS. Effect of an Indo-Mediterranean diet on progression of coronary artery disease in high risk patients (Indo-Mediterranean Diet Heart Study): a randomized single- blind trial. Lancet, v. 360, p. 1455-1461,2002.
https://doi.org/10.1016/S0140-6736(02)11472-3

29. LIU S, STAMPFER MJ, HU FB, GIOVANNUCCI E, RIMM E, MANSON JE. Wholegrain consumption and risk of coronary heart disease: results from the Nurses'. Health Study. Am J Clin Nutr, v. 70, p. 412-419,1999.

30. HARDMAN AE. Physical activity and cancer risk. Proc Nutr Soc, v. 60, p. 107-113,2001.
https://doi.org/10.1079/PNS200076

31. JURCA R, LAMONTE MJ, CHURCH TS, EARNEST CP, FITZGERALD SJ, BARLOW CE. Associations of muscle strength and aerobic fitness with metabolic syndrome in men. Med Sci Sports Exerc, v. 36, p. 1301-1307,2004.
https://doi.org/10.1249/01.MSS.0000135780.88930.A9

32. LEON AS, SANCHEZ O. Meta-analysis of effects of aerobic exercise training on blood lipids. Circulation, v. 104(suppl II), p. II414-II415,2001.

33. KNOWLER WC, BARRETT-CONNOR E, FOWLER SE. Reduction of the incidence of type II diabetes with lifestyle intervention of metformin. N Engl J Med, v. 344, p.393-403,2002.
https://doi.org/10.1056/NEJMoa012512

34. PATE RR, PRATT M, BLAIR SN. Physical activity and public health recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. JAMA, v. 273, p. 401-407,1995.
https://doi.org/10.1001/jama.1995.03520290054029

35. JANSSEN I, KATZMARZYK PT, ROSS R. Body mass index, waist circumference, and health risk. Arch Intern Med, v. 162, p. 2074-2079,2002.
https://doi.org/10.1001/archinte.162.18.2074

36. CHAN DC, WATTS GF, BARRETT PHR, BURKE V. Waist circumference, waist-to-hip ratio and body mass index as predictors of adipose tissue compartments in men. Q J Med, v. 96, p. 441-447,2003.
https://doi.org/10.1093/qjmed/hcg069

37. CARR DB, UTZSCHNEIDER KM, HULL RL, KODAMA K, RETZLAFF BM, BRUNZELL JD.Intra-abdominal fat is a major determinant of the National Cholesterol Education Program Adult Treatment Panel III criteria for the Metabolic Syndrome. Diabetes,v. 53, p. 2087-2094,2004.
https://doi.org/10.2337/diabetes.53.8.2087

38. MOHAMED-ALI V, PINKNEY JH, COPPACK SW. Adipose tissue as an endocrine and paracrine organ. Int JObes,22:1145-58,1998.
https://doi.org/10.1038/sj.ijo.0800770

39. GIORGINO F, LAVIOLA L, ERIKSSON JW. Regional differences of insulin action in adipose tissue: insights from in vivo and in vitro studies. Acta Physiol Scand, 183:13-30,2005.
https://doi.org/10.1111/j.1365-201X.2004.01385.x

40. HARMELEN VV, REYNISDOTTIR S, ERIKSSON P, THÖRNE A, HOFFSTEDT J, LÖNNQVIST F. Leptin secretion from subcutaneous and visceral adipose tissue in women. Diabetes,47:913-7,1998.
https://doi.org/10.2337/diabetes.47.6.913

41. WORLD HEALTH ORGANIZATION. Obesity: preventing and managing the global epidemic. Report of a WHO consultation on obesity. Geneve:World Health Organization;1997

42. MATSUNAGA Y. Pathophysiology and molecular mechanisms of visceral fat syndrome: the Japanese experience. Diabetes Metab Rev,13:3-13,1997.
https://doi.org/10.1002/(SICI)1099-0895(199703)13:1<3::AID-DMR178>3.0.CO;2-N

43. RIBEIRO FILHO, FERNANDO F., MARIOSA, LYDIA S., FERREIRA, SANDRA R. G. Gordura visceral e síndrome metabólica: mais que uma simples associação. Arq Bras Endocrinol Metab, vol.50, no. 2, p.230-238,2006.
https://doi.org/10.1590/S0004-27302006000200009

44. DESPRÉS JP. The insulin resistance-dyslipidemic syndrome of visceral obesity: effect on patients' risk. Obes Res,6:8S-17S,1998.
https://doi.org/10.1002/j.1550-8528.1998.tb00683.x

45. LAMARCHE B, LEMIEUX S, DAGENAIS GR, DEPRES JP. Visceral obesity and the risk of ischaemic heart disease: insights from the Quebec Cardiovascular Study. Growth Horm IGF Res ;8:1-8,1998.
https://doi.org/10.1016/S1096-6374(98)80018-X

46. BOYKO EJ, FUJIMOTO WY, LEONETTI DL, NEWELL-MORRIS L. Visceral adiposity and risk of type 2 diabetes: a prospective study among Japanese Americans. Diabetes Care,23:465-71,2000.
https://doi.org/10.2337/diacare.23.4.465

47. RIBEIRO-FILHO FF, FARIA AN, KOHLMANN NE, ZANELLA MT, FERREIRA SR. Two-hour insulin determination improves the ability of abdominal fat measurement to identify risk for the metabolic syndrome. Diabetes Care, 26:1725-30,2003.
https://doi.org/10.2337/diacare.26.6.1725

48. FARIA AN, RIBEIRO FILHO FF, GOUVEIA FERREIRA SR, ZANELLA MT. Impact of visceral fat on blood pressure and insulin sensitivity in hypertensive obese women. Obes Res, 10:1203-6,2002.
https://doi.org/10.1038/oby.2002.164

49. CARNEIRO G, FARIA AN, RIBEIRO FILHO FF, GUIMARÃES A, LERÁRIO D, FERREIRA SR. Influence of body fat distribution on the prevalence of arterial hypertension and other cardiovascular risk factors in obese patients. Rev Assoc Med Bras,49:306-11,2003.
https://doi.org/10.1590/S0104-42302003000300036

50. WAJCHENBERG BL. Subcutaneous and visceral adipose tissue: their relation to the metabolic syndrome. Endocrine Rev ,21:697-738,2000.
https://doi.org/10.1210/er.21.6.697

51. FERREIRA SR, LERÁRIO DD, GIMENO SG, SANUDO A, FRANCO LJ; Japanese-Brazilian Diabetes Study Group. Prevalence and 7-year incidenceoftype II diabetes mellitus in a Japanese-Brazilian population: an alarming public health problem. Diabetologia,45:1635-8,2002. https://doi.org/10.1007/s00125-002-0963-x

52. EGGER G. The case for using waist to hip ratio measurements in routine medical checks. Med J Aust, 156:280-5,1992.

53. RÖSSNER S, BO WJ, HILTBRANDT E, HINSON W, KARSTAEDT N, SANTAGO P. Adipose tissue determinations in cadavers a comparison between cross-sectional planimetry and computed tomography. Int J Obes,14:893- 02,1990.

54. YOSHIZUMI T, NAKAMURA T, YAMANE M, ISLAM AHW, MENJU M, YAMASAKI K. Abdominal fat: standardized technique for measurement at CT. Radiology, 211:283-6,1999. https://doi.org/10.1148/radiology.211.1.r99ap15283

55. KOOY K, SEIDELL JC. Techniques for the measurements of visceral fat: a practical guide. Int J Obes 1993;17:187-96,1993.

56. WILLIAMS MJ, HUNTER GR, KEKES-SZABO T, TRUETH MS, SNYDER S, BERLAND L. Intra-abdominal adipose tissue cut-points related to elevated cardiovascular risk in women. Int J Obes,20:613-7,1996.

57. PARADISIG,SMITHL,BURTNERC,LEAMINGR,GARVEYWT,HOOK

G. Dual energy x-ray absorptiometry assessment of fat mass distribution and its association with the insulin resistance syndrome. Diabetes Care,22:1310-7, 1999. https://doi.org/10.2337/diacare.22.8.1310

58. ARMELLINI F, ZAMBONI M, RIGO L, TODESCO T, BERGAMO-ANDREIS IA, PROCACCI C. The contribution of sonography to the measurement of intra- abdominal fat. J ClinUltrasound,18:563-7,1990. https://doi.org/10.1002/jcu.1870180707

59. ARMELLINI F, ZAMBONI M, ROBBI R, TODESCO T, RIGO L, BERAGMO- ANDREIS IA. Total and intra-abdominal fat measurements by ultrasound and computed tomography. Int J Obes1993;17:209-14.

60. RIBEIRO FILHO FF, FARIA AN, KOHLMANN JR. O, AJZEN S, RIBEIRO AB, ZANELLA MT. Ultrasonography for the evaluation of visceral fat and cardiovascular risk. Hypertension,38:713-7,2001. https://doi.org/10.1161/01.HYP.38.3.713

61. RIBEIRO FILHO FF, FARIA AN, AZJEN S, ZANELLA MT, FERREIRA SRG. Methods of estimation of visceral fat: advantages of ultrasonography. Obes Res, 11:1488-94,2003. https://doi.org/10.1038/oby.2003.199

62. BARRATA M. leptin: from a signal of adiposity to a hormone mediator in peripheral tissues. Nature, 22, 763-770,1998.

63. WEBBER J. Energy balance in obesity. Proc Nutr Soc, 62,539-543,2003.
https://doi.org/10.1079/PNS2003256

64. PICK JC, CROOK M. Is this type II diabetes mellitus a disease of the innate immune system? Diabetologia, 41, 1241-1248,1999.
https://doi.org/10.1007/s001250051058

65. BERG AH, COMBS TP, DU X, BROWNLEE M, SHERER PE. The adipocyte- secreteded protein ACrp30 enchanges insulin action. Nat Med, 77, 947-94,2001.
https://doi.org/10.1038/90992

66. YAMAUCHI T. The fat deriveted hormone adiponectina reverses insulinresistence associated with both lipoatrophy and obesity. Nat Med, 7, 941- 946,2001.
https://doi.org/10.1038/90984

67. FRUEBIS J, TSAO TS, JAVORSCHI S. Proteolytic cleavage product of 30-kDa complement-releted protein increases fatty acid oxidation I muscle and causes weight loss in mice. Proc Natl Acad Sci, 98, 2005-2010,2001.
https://doi.org/10.1073/pnas.041591798

68. YAMAUCHI T, KAMON J, MINOKOSHI Y. Adiponectin stimulates glucose utilization and fat-acid oxidation by activation AMP-activated protein kinase. Nat Med, 8, 1288-1295,2002.
https://doi.org/10.1038/nm788

69. BAYS H, MANDARINO L, DEFRONZO RA. Role adipocyte, free fat acids, and ectopic fat in pathogenisis of type 2 diabetes mellitus: peroxisomal proliferator- activated receptor agonists provide a rational therapeutic approach. J Clin Endocrinol Metab,89, 463-478,2004.
https://doi.org/10.1210/jc.2003-030723

70. MCTERMAN PG, FISCHER FM, HARTE AL, LEVICK PL, BARNETT AH, KUMAR S. Resistin, central obesity, and type 2 diabetes. Lancet, 359, 46-47, 2002.
https://doi.org/10.1016/S0140-6736(02)07281-1

71. RAHMOUNI K, MARK AL, HAYNES WG, SIGMUND CD. Adiposem depot- specific modulation of angiotensinogen gene expression in diet-induced obeity. Am J Endocrinol metab, 286, 891-895,2004.
https://doi.org/10.1152/ajpendo.00551.2003

72. VELLOSO LA, FOLLI F, SUN XJ, WHIFE MF, SAAD M, KAHN CR. Cross- talk between the insulin and angiotensina signaling systems. Proc Natl Acad Sci, 93,12490-12495, 1996.
https://doi.org/10.1073/pnas.93.22.12490

73. HAINAULT I, NEBOUT G, TURBAN S, ARDOIN B, FERRE P, QUIGNARD- BOULANGE A.

Adipose tissue-specific increase in angiotensinogen expreesion in obese (falfa) zucker rat. Am J Physiol, 282, 59-66,2002.
https://doi.org/10.1152/ajpendo.2002.282.1.E59

74. BIRGEL M,GOTTSCHILING_ZELLER H, ROHRIG K, HAUNER H. Role of cytokines in the regulation of plasminogen activator inhibitor-1 expression and secretion in newly differentiated subcutaneous human adipocytes. Arterioscler Thromb Vasc Biol, 20, 1682-1687,2000.
https://doi.org/10.1161/01.ATV.20.6.1682

75. HOTAMISLIGIL GS, SHARGILL NS, SPIGUELMAN BM. Adipose expression of tumor necrosis factor alfa: direct role in obesity-linked insulin resistence. Science, 259, 87-91,1993.
https://doi.org/10.1126/science.7678183

76. MIYASAKI Y, PIPEK R, MANDARINO, DEFRONZO RA. Tumor necrosis factor alfa and insulin resistence in obese type 2 diabetic patients. Int J Obes, 27, 88-94,2003.
https://doi.org/10.1038/sj.ijo.0802187

77. VANSNICK J. Inteleikin 6: an over-view. Ann Rev Immunol, 8, 253-334,2001.

78. PRADHAN AD, MANSON JE, RIFAI N, BURING JE, RIDKER PM.C-Reactive protein, interleukin 6, and risk of developing type 2 diabetes. JAMA, 286, 327,334, 2001.
https://doi.org/10.1001/jama.286.3.327

79. CHOY LN, ROSEN BS, SPIGELMAN BM. Adipsin an endogenous pathway for complement from adipose cells. J Biol Chem, 267, 12736-12741,1992.

80. CIANFLONE K, MASLOWSKA M, SNIEDERMAN AD. Acylation stimulation protein (ASP), an adipocyte autocrine: new directions. Semin Cell Dev, 10, 31- 41,1999.
https://doi.org/10.1006/scdb.1998.0272

81. FUKARA A, MATSUDA M, NISHIZAWA M. Visfatin: a protein secreted by visceral fat that mimics effects of insulin. Science, 307, 426-430,2005.
https://doi.org/10.1126/science.1097243

82. HALL JE. The Kidney, hypertension, and obesity. Hipertension, 41: 625-633, 2003.
https://doi.org/10.1161/01.HYP.0000052314.95497.78

83. UNGER RH. Lipid oxidation and overflow: metabolic trauma and the metabolic syndrome trendes. Endocrinol Metab, 14: 398,2003.
https://doi.org/10.1016/j.tem.2003.09.008

84. RAO MS, REDDY JK. PPASa in pathogenisis of fat liver disease.Hepatology,

40: 793, 2004.

85. SOCIEDADE BRASILEIRA DE CARDIOLOGIA. IV Diretriz Brasileira Sobre Dislipidemias e

Prevenção da Aterosclerose. Departamento de Aterosclerose, São Paulo,2007.

86. GODOY - MATOS, A.F. Síndrome Metabólica. São Paulo, Atheneu,2006.

87. AILHAUD G, FUKAMUZI A, MASSIERA F, NEGREL R, SAINT-MARC P, TEBOUL M. Angiotensinogen, angiotensin II and adipose tissue development. Int J Obes Relat Metab Disord, 24: S33-S35,2000.
https://doi.org/10.1038/sj.ijo.0801501

88. DUSSERRE E, MOULIN P, VIDAL H. Differences in mRNA expression of the proteins secreted by the adipocytes in human subcutâneos and visceral adipose tissues. Biochim Biophys Acta, 1500: 88-96,2000.
https://doi.org/10.1016/S0925-4439(99)00091-5

89. DESSI-FULGHERI P. Low calorie diet enchanges renal, hemodynamic, and humoral effects of exogenous atrial natriuretic peptide (ANP) in obese hypertensives. Hypertension, 33(2): 658-662,1999.
https://doi.org/10.1161/01.HYP.33.2.658

90. HALLJE.Mechanismofabnormalrenalsodiumhandlinginobesehypertension.

Am J Hypertens, 10: S49-S55, 1997.
https://doi.org/10.1016/S0895-7061(97)90006-6

91. SESSO HD, BURINGJE, RIFAI N, BLAKE GJ, GAZIANO JM, RIDKER PM. C-reative protein and the risk of developing hypertension. JAMA, 290(22): 2945- 2951,2003.
https://doi.org/10.1001/jama.290.22.2945

92. SUZUKI Y, RUIZ-ORTEGA M, LORENZO O, RUPEREZ M, ESTEBAN V, EGIDO J. Inflammation and angiotensin II. Int J Biochem Cell biol 2003; 35(6): 881-900.
https://doi.org/10.1016/S1357-2725(02)00271-6

93. ENGELINE S, NEGREL R, SHARMA AM. Physiology na pathophysiology of the adipose tissue renin-angiotensin system. Hypertension, 35: 1270-1277,2000.
https://doi.org/10.1161/01.HYP.35.6.1270

94. VAN DER POORTEN D, MILNER KL, HUI J, HODGE A, TRENELL MI, KENCH JG, LONDON R, PEDUTO T, CHISHOLM DJ, GEORGE J. Visceral fat: A key mediator of steatohepatitis in metabolic liver disease. Hepatology, Apr 11.

95. RITZ E. Metabolic syndrome and kidney disease. Blood Purif, 26(1):59-62, 2008.
https://doi.org/10.1159/000110566

96. WAJCHENBERG BL. Tecido adiposo como glândula endócrina. Arq Bras Endocrinol Metab, 44(1):13-20,2000.
https://doi.org/10.1590/S0004-27302000000100004

97. LEITE CC, WAJCHENBERG BL, RADOMINSKI R, MATSUDA D, CERRI GG, HALPERN A. Intra-abdominal thickness by ultrasonography to predict risk factors for cardiovascular disease and its correlation with anthropometric measurements. Metabolism, 51: 1034-40,2002.
https://doi.org/10.1053/meta.2002.34035

98. AHIMA RS. Central actions of adipocyte hormones. TEM.;16:307-13,2005.
https://doi.org/10.1016/j.tem.2005.07.010

99. Harrison DG, Guzik TJ, Goronzy J, Weyand C. Is hypertension an immunologic disease? Curr Cardiol Rep. Nov;10(6):464-9,2008.
https://doi.org/10.1007/s11886-008-0073-6

100. Manolescu B, Stoian I, Atanasiu V, Busu C, Lupescu O. Review article: The role of adipose tissue in uraemia-related insulin resistance. Nephrology (Carlton). Sep 25, 2008 [Epub ahead ofprint].
https://doi.org/10.1111/j.1440-1797.2008.01022.x

101. Tokuyama H, Wakino S, Ito H. [Obesity in CKD]. Nippon Rinsho.

Sep;66(9):1770-7, 2008.

102. Sarafidis PA. Obesity, insulin resistance and kidney disease risk: insights into the relationship. Curr Opin Nephrol Hypertens.Sep;17(5):450-6,2008.
https://doi.org/10.1097/MNH.0b013e328305b994

103. Obligado SH, Goldfarb DS. The association of nephrolithiasis with hypertension and obesity: a review. Am J Hypertens. Mar; 21(3):257-64, 2008.
https://doi.org/10.1038/ajh.2007.62

104. AxelssonJ.Obesityinchronickidneydisease:goodorbad?BloodPurif.

26(1):23-9.2008.

105. Chen H, Liu Z, Li S, Chen Y, Yang B, Cai J, Wang Q, Li L. The relationship between body fat distribution and renal damage in Chinese with obesity. Exp Clin Endocrinol Diabetes. Feb;116(2):99-103,2008.
https://doi.org/10.1055/s-2007-992117

106. Axelsson J, Stenvinkel P. Role of fat mass and adipokines in chronic kidney disease. Curr Opin Nephrol Hypertens. Jan;17(1):25-31,2008.
https://doi.org/10.1097/MNH.0b013e3282f2905f

107. Chalmers L, Kaskel FJ, Bamgbola O. The role of obesity and its bioclinical correlates in the progression of chronic kidney disease. Adv Chronic Kidney Dis. Oct;13(4):352-64,2006.
https://doi.org/10.1053/j.ackd.2006.07.010

108. Axelsson J, Heimbürger O, Stenvinkel P. Adipose tissue and inflammation in chronic kidney

disease. Contrib Nephrol.151:165-74,2006.
https://doi.org/10.1159/000095327

109. Shoji T, Ishimura E, Nishizawa Y. Body fat measurement in chronic kidney disease: implications in research and clinical practice. Curr Opin Nephrol Hypertens.Nov;16(6):572-6,2007.
https://doi.org/10.1097/MNH.0b013e3282f0d22f

110. Kume S, Uzu T, Araki S, Sugimoto T, Isshiki K, Chin-Kanasaki M, Sakaguchi M, Kubota N, Terauchi Y, Kadowaki T, Haneda M, Kashiwagi A, Koya D. Role of altered renal lipid metabolism in the development of renal injury induced by a high-fat diet. J Am Soc Nephrol.Oct;18(10):2715-23,2007.
https://doi.org/10.1681/ASN.2007010089

111. Fonseca-Alaniz M. H, Takada J, Alonso-ValeMIC, Lima B. S. O tecido adiposo como órgão endócrino: da teoria à prática. J Pediatr (Rio J);83(5 Supl):S192-203, 2007.
https://doi.org/10.1590/S0021-75572007000700011

112. Sower JR.Endocrine functions of adipose tissue: focus on adiponectin. Clin Cornestone. 9(1):32-40,2008.
https://doi.org/10.1016/S1098-3597(08)60026-5

113. Martínez Castelao A. Metabolic syndrome and kidney disease. Nefrolologia. 3:33- 7,2008.

114. Guize L, Pannier B, Thomas F, Bean K, Jégo B, Benetos A. Recent advances in metabolic syndrome and cardiovascular disease. Arch Cardiovascular Dis. 101(9):577-83,2008.
https://doi.org/10.1016/j.acvd.2008.06.011

115. Andreassi MG. Metabolic syndrome, diabetes and atherosclerosis: Influence or gene-environment interaction. Mutat Res. Nov 2008. Epub ahead ofprint.

116. Koshizaka M, Ishikawa K, Ishibashi R, Maezawa Y, Sakamoto K, Uchida D, et. Al. Comparing the effects of ipragliflozin versus metformin on visceral fat reduction and metabolic dysfunction in Japanese patients with type 2 diabetes treated with sitagliptin: A prospective, multicentre, open-label, blinded-endpoint, randomised controlled study (PRIME-V study).Diabetes Obes Metab. 2019 Apr 17. doi: 10.1111/dom.13750.
https://doi.org/10.1111/dom.13750

117. Goldberg EK, Fung EB. Precision of the Hologic DXA in the Assessment of Visceral Adipose Tissue.J Clin Densitom. 2019 Mar 20. pii: S1094-6950(19)30002-2.

118. Christensen MA, Smoak P, Lisano JK, Hayward R, Coronado C, Kage K, et. al. Cardiorespiratory fitness, visceral fat, and body fat, but not dietary inflammatory index, are related to C-reactive protein in cancer survivors.Nutr Health. 2019 Apr 16:260106019841840.
https://doi.org/10.1177/0260106019841840

119. Tian YM, Ma N, Jia XJ, Lu Q. The "hyper-triglyceridemic waist phenotype" is a reliable marker for prediction of accumulation of abdominal visceral fat in Chinese adults.Eat Weight Disord. 2019 Apr 15. doi: 10.1007/s40519-019-00677-w.

https://doi.org/10.1007/s40519-019-00677-w

Termo de Consentimento Livre e Esclarecido (I)

Você está sendo convidado a participar da pesquisa "Gordura visceral, subcutânea e peri-renal na Síndrome Metabólica: Estudo de Correlação com Fatores de Risco para Aterotrombose Utilizando a Ultra-Sonografia.", sob a responsabilidade dos pesquisadores Prof. Dr. Elmiro Santos Resende, mestrando Leonardo Silva Roever Borges.

Nesta pesquisa procuraremos entender o efeito do exercício aeróbio versus o de resistência associado ao aeróbio sobre os depósitos de gordura corporal em pacientes portadores de Síndrome Metabólica. A pesquisa consistirá na realização de avaliação da história clínica, exame físico, exames laboratoriais e complementares.

Eu,

_____

concordo em participar desta pesquisa ciente da realização das avaliações (serão coletados 18,5 ml de sangue), e que a qualquer momento e por qualquer razão posso interromper minha participação nessa pesquisa, sem nenhum tipo de represaria. .

Em nenhum momento o participante será identificado. Os resultados da pesquisa serão publicados e ainda assim a sua identidade será preservada

Fui informado (a) de que as informações coletadas a meu respeito ficarão à disposição, caso necessário, das autoridades regulamentadoras, do patrocinador do estudo ou assistentes, e que as informações serão mantidas em sigilo e se os resultados forem publicados não serei identificado.

O participante não terá nenhum ônus e ganho financeiro por participar na pesquisa.

Em caso de dano pessoal, diretamente causado pelos procedimentos propostos nesse estudo, o participante terá direito a tratamento médico na instituição.

Uma cópia deste termo livre e esclarecido ficará com o senhor(a).

Qualquer dúvida a respeito da pesquisa o senhor (a) poderá entrar em contato com: Pesquisadores: Prof. Dr. Elmiro Santos Rezende, Av. Pará, Fone. 3239-4805, Leonardo Silva Roever Borges, Fone: 8803-9878. CEP/UFU: 34-3239-4531.

Confirmo, por meio deste, que concordo em participar deste estudo de maneira plenamente voluntária.

_____

Assinatura do (a) participante da pesquisa.

Termo de Consentimento Livre e Esclarecido (II)

Você está sendo convidado a participar da pesquisa "Avaliação da gordura abdominal através da ultra-sonografia", sob a responsabilidade dos pesquisadores Prof. Dr. Elmiro Santos Resende, Prof. Dra. Angélica Lemos Debs Diniz, mestrando Leonardo Silva Roever Borges.

O participante irá se submeter ao exame (não invasivo) de ultra-sonografia abdominal de rotina, para avaliar a espessura da gordura visceral, sendo que este é um exame que irá favorecer no diagnóstico e acompanhamento das alterações metabólicas, e tem em média a duração de cincominutos.

A ultra-sonografia é um exame que não causa dor e não tem riscos a saúde. O participante ficara deitado e passaremos um transdutor no abdome com gel, sendo então realizado o exame de observação das imagens e obtenção das medidas.

Em nenhum momento o participante será identificado. Os resultados da pesquisa serão publicados e ainda assim a sua identidade será preservada. E a qualquer momento e por a qualquer razão posso interromper minha participação nessa pesquisa, sem nenhum tipo derepresaria.

Em caso de dano pessoal, diretamente causado pelos procedimentos propostos nesse estudo, o participante terá direito a tratamento médico na instituição.

Fui informado (a) de que as informações coletadas a meu respeito ficarão à disposição, caso necessário, das autoridades regulamentadoras (Prof. Dr. Elmiro Santos Resende, Prof. Dra. Angélica Lemos Debs Diniz, Mestrando Leonardo Roever) e que as informações serão mantidas em sigilo e se os resultados forem publicados não serei identificado.

O participante não terá nenhum ônus e ganho financeiro por participar na pesquisa.

Qualquer dúvida a respeito da pesquisa o senhor (a) poderá entrar em contato com: Pesquisadores: Prof. Dr. Elmiro Santos Rezende, Prof. Dra. Angélica Lemos Debs Diniz, Av. Pará, Fone. 3239-4805/3218-2186, Mestrando Leonardo Silva Roever Borges, fone: 9918-9878. CEP/UFU: 34-3239-4531

Confirmo, por meio deste, que concordo em participar deste estudo de maneira plenamente voluntária.

Assinatura do (a) participante da pesquisa

Avaliação

Prontuário:
Sexo:□M□F Data:

Subjetiva
Idade:
Tabagismo:
Álcool:
História pregressa de hipertensão:
Diabetes:
Doença arterial coronariana:
Acidente vascular encefálico:
Síndrome dos ovários policísticos:
Hiperuricemia:
Doença hepática gordurosa não alcoólica:
História familiar de hipertensão, diabetes e doença cardiovascular:
Medicamentos:

Pratica de atividades físicas:
Modalidade: Freqüência: Duração: Intensidade:
Obs:

Objetiva
- Circunferência Abdominal(cm)
- Pressão arterial de repouso(mmHg)
- Índice de massa corporal (IMC):
    - Peso(kg):
    - Altura (cm):
- Hematócrito:
- Hemoglobina:
- TSH:
- Triglicérides(mg/dl):
- Colesteroltotal:
- Fosfatase Alcalina:
- LDL(mg/dl):
- HDL(mg/dl):
- GGT:
- TGO:
- TGP:
- Fibrinogênio:
- Cortisol:
- Glicemia de Jejum(mg/dl):
- Teste de esforço (Protocolo deBruce):

- Ultra-sonografia: GSC: GV:
  GPR: GVPR:

Avaliação

Plano