UNIVERSITAT DE BARCELONA

Aportes Metodológicos para el Estudio de los Entornos Alimentarios en Población Escolar

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FACULTAD DE FARMACIA Y CIENCIAS DE LA ALIMENTACIÓN
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A mi hija Helena, quien llegó para darme

el chispazo final de motivación que

tanto necesitaba.

Hija, en tus ojos veo más claro

el camino

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"La utopía está en el horizonte.
Me acerco dos pasos, ella se aleja dos pasos
Camino diez pasos y el horizonte se desplaza diez pasos más allá.
Entonces, ¿para qué sirve la utopía?
Para eso, sirve para caminar"
Eduardo Galeano

Si me hubieran preguntado hace un par de años sobre la posibilidad de acabar un doctorado, seguramente hubiera dicho que era una utopía. Luego, empecé a caminar, y sin pensarlo me encuentro a punto de terminarlo. En medio de este camino he tenido la fortuna de contar con maestros, amigos, compañías y ejemplos que me han enseñado que lo bonito de la buscar la utopía no es conseguirla, sino disfrutar caminando. Doy las gracias a todas las personas que han caminado de alguna manera a mi lado en este viaje hacia la utopía.

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LISTA DE ABREVIATURAS

AI	Área de Interés
ALADINO	Alimentación, Actividad Física, Desarrolo Infantil y Obesidad
BMI	Body Mass Index
CVI	Content Validity Index
DM	Dieta Mediterranea
ENPE	Estudio Nutricional de la Población Española
ESCA	Encuesta de Salud de Cataluña
FLC	Facility List Coder
FFE	Entorno Alimentario Familiar (por sus siglas en inglés)
GIS	Geographic Information System
HELENA	Healthy Lifestyle in Europe by Nutrition in Adolescence
IMC	Índice de Masa Corporal
ICC	Coeficiente de Correlación Inter-clase
KIDMED	Mediterranean Diet Quality Index for children and adolescents
MVPA	Moderate to Vigorous Physical Activity
MSCBS	Ministerio de Sanidad, Consumo y Bienestar Social
NEMS	Nutrition Environment Measure Survey
OMS	Organización Mundial de la Salud
PASOS	Physical Activity, Sedentarim and Obesity of Spanish youth
S-CVI	Content Validity of the Overall Scale
SPAN-ET	School Physical Activity and Nutrition Environment Tool
SPAN-ET-ES	Versión validada para el contexto español el SPAN-ET
SPOTLIGHT	Sustainable Prevention of Obesity Through Integrated Strategies
S-VAT	SPOTLIGHT Virtual Audit Tool
THAO	Think Actions Obesity
TPA	Total Physical Activity

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RESUMEN

En su mayoría, las intervenciones para disminuir la prevalencia de la obesidad y promover la adopción de patrones de alimentación y hábitos saludables en población escolar, se han basado en incentivar cambios conductuales bajo el precepto de *comer menos y moverse más*. No obstante, esta aproximación asume que los niños y jóvenes se desenvuelven en entornos neutrales que no generan influencias en sus hábitos, dejando de lado la compresión de cómo dichos entornos pueden facilitar u obstaculizar la elección de alimentos saludables y oportunidades de movimiento. En este sentido, existe una necesidad de construir nuevos marcos analíticos y metodológicos que permitan el estudio e inclusión de los diferentes entornos en los análisis e intervenciones nutricionales en población en edad escolar.

En este orden de ideas, el objetivo central de esta tesis fue desarrollar herramientas metodológicas para el estudio de las variables ambientales en población en edad escolar, con el fin de facilitar la compresión de la relación de los entornos con la adherencia a patrones de alimentación y estilo de vida saludables. En el primer capítulo, se parte de una aproximación descriptiva sobre los principales factores individuales y ambientales asociados a la adherencia a patrones de alimentación saludables en una población escolar, usando el estudio de la adherencia a la dieta mediterránea en la población escolar de la ciudad de Mataró, España. El análisis estadístico demostró que los factores positivamente asociados con una adherencia óptima a la dieta mediterránea fueron: (i) el nivel de educación de la madre; (ii) estar cursando la primaria; (iii) la ausencia de distracciones durante el desayuno; y por último, (iv) la actividad física regular vigorosa y ligera. Adicionalmente, sobresalió cómo la disponibilidad de dinero para comprar en la escuela/instituto presentó una asociación negativa con la probabilidad de adherencia óptima a la dieta mediterránea, lo cual se relaciona con una posible influencia de los entornos comunitarios como factor a considerar para garantizar el éxito de las intervenciones en la población de edad escolar.

En el segundo y tercer capítulo, se introdujo el *Facility List Coder* (FLC) una nueva herramienta basada en información geo-localizada secundaria para la evaluación automática de entornos de alimentación a nivel comunitario. El FLC es un aplicativo que realiza un inventario de establecimientos con diferentes ofertas de alimentos alrededor de un sitio de interés (escuelas, parques, entre otros), a través de una consulta espacial de las principales bases de datos espaciales accesibles (Google Maps y Open Street Maps). Dicha información es analizada y clasificada a través de una lista de categorías preestablecidas que permiten tener medidas cuantitativas sobre la calidad y tipologías de los entornos de alimentación. Después del proceso de validación se concluyó que el FLC es una herramienta de bajo costo, escalable, eficiente, fácil de usar, fiable y

válida para la evaluación de entornos de alimentación comunitarios de manera automática a través de uso de información secundaria geo-referenciada.

Finalmente, el capítulo 4 adapta y valida a la cultura española una nueva herramienta para evaluar el micro-entrono escolar llamada *School Physical Activity and Nutrition Environment Tool* (SPAN-ET), la cual permite una evaluación integral del entorno de actividad física y nutrición teniendo en cuenta aspectos físicos, situacionales y de política. Para esto, se aplicaron las directrices metodológicas para la adaptación transcultural de instrumentos de recolección de información y se aplicó un análisis de validez del contenido. La evaluación realizada por el comité de expertos concluyó que los elementos incluidos en la versión SPAN-ET en español eran relevantes para el contexto español, claros, sencillos y sin ambigüedades. Por tanto, se dispone de una nueva herramienta para la evaluación de entornos escolares en España.

Como resultado de esta tesis se puede concluir que existe una necesidad global de crear marcos analíticos y metodológicos que permitan estudiar las dinámicas e interacciones de las variables ambientales (entorno de alimentación comunitario, entorno de consumo, entornos organizacionales y entorno informacional) sobre la adherencia a patrones de alimentación y estilos de vida saludables. En particular, en el entorno comunitario alrededor de las escuelas y en el micro-entorno escolar, ya que constituye la dimensión con menos investigación disponible y es el lugar donde las intervenciones podrían tener mayor impacto en la formación de hábitos saludables.

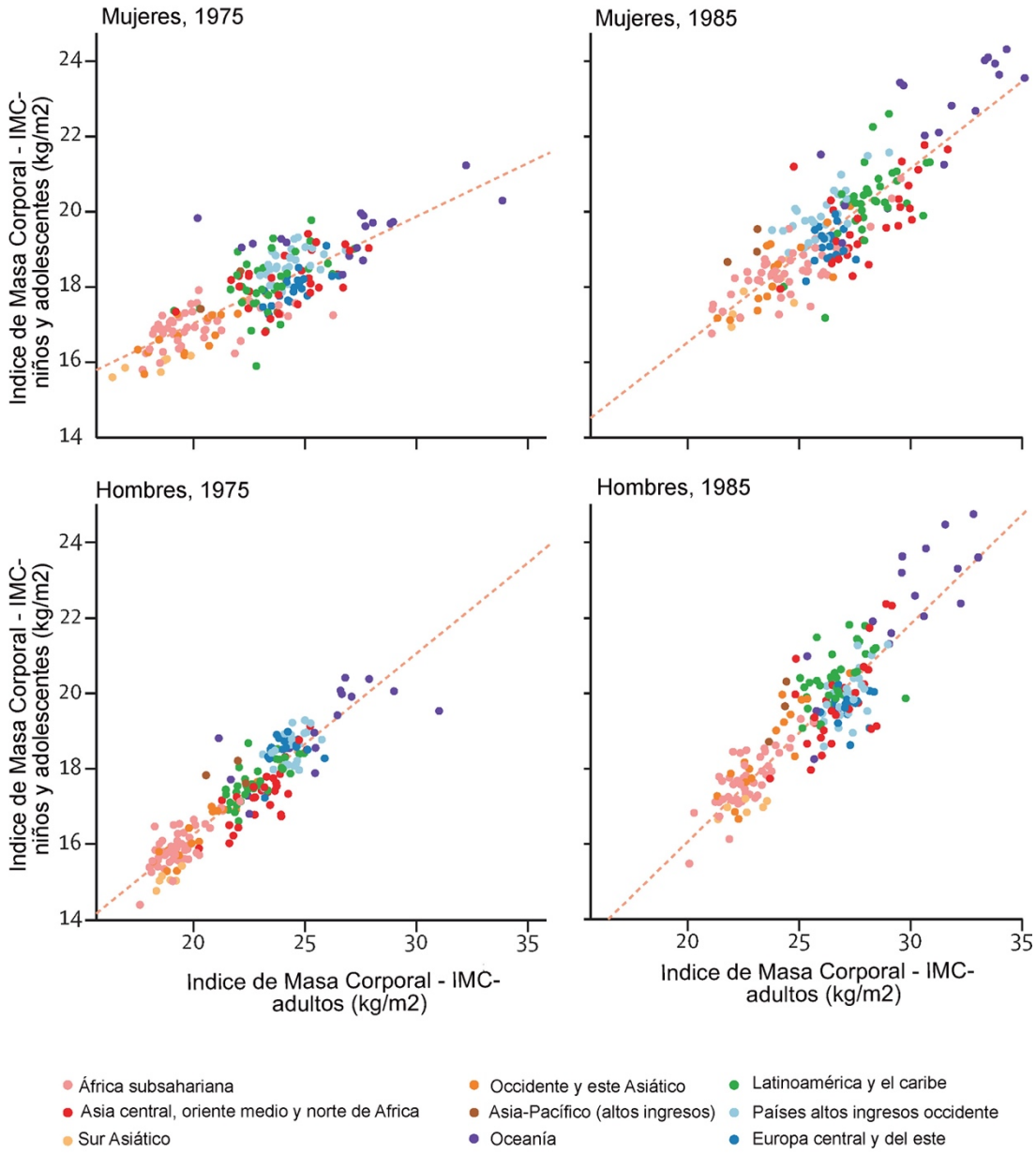
I. INTRODUCCION

En los estatutos constitutivos de la Organización Mundial de la Salud – OMS – en 1946 se definió la salud como un estado de *"[…]completo bienestar físico, mental y social, y no solamente la ausencia de afecciones o enfermedades"* (1). Hoy, después de casi 80 años, esta visión holística sobre la salud es más pertinente que nunca. La necesidad de incluir el bienestar físico, mental y social como tres dimensiones necesarias para un estado de salud adecuado, se presenta como un reto fundamental en la elaboración de políticas de salud pública dirigidas a garantizar y promover hábitos saludables durante las diferentes etapas de la vida (2–4).

Este aspecto multidimensional del concepto de salud es fundamental para entender el proceso de salud-enfermedad en la sociedad actual. En efecto, la dinámica de este proceso puede ser acelerada o frenada a través de dos factores: los internos y externos. Los primeros, hacen referencia a aspectos genéticos, biológicos o psicológicos que generan una predisposición a que un individuo determinado desarrollo una patología. Los segundos, se refieren a las dimensiones sociales, físicas y medioambientales que dan cuenta del grado de adaptación del ser humano a su entorno, en especial, al estilo de vida (5). Aunque ambos factores pueden ser detonantes del proceso de enfermedad, la evidencia científica sugiere que los factores externos, especialmente aquellos asociados a los hábitos de vida, juegan un papel determinante: "[…] *los factores genéticos dominan la susceptibilidad individual a la enfermedad, pero el ambiente y el estilo de vida, dominan la incidencia y la prevalencia*" (5). En este orden de ideas, la promoción de estilo de vida y patrones de alimentación saludables en todas las etapas del ciclo vital, se convierte en una herramienta necesaria para garantizar el bienestar de la población (5–7).

De acuerdo a las últimas estimaciones, la media del Índice de Masa Corporal (IMC) y la prevalencia obesidad en niños y adolescentes entre 5-19 años se ha incrementado en la mayoría de regiones y países del mundo desde 1975 a 2016 (3). Esto se ha traducido en el incremento de la aparición temprana de enfermedades crónicas no transmisibles y su permanencia a través de la vida (8). La Figura 1 presenta la evidencia existente del incremento positivo de la obesidad a nivel mundial y además demuestra cómo el tener índices altos de IMC durante edades tempranas (eje-x) marca una tendencia persistente sobre el tiempo, haciendo que el IMC en personas adultas (eje-y) también se sitúe en valores altos. Es decir, la mayoría los países con altos índices de IMC en niños y jóvenes también presentan índices de IMC altos en la población adulta (3).

Figura 1. Comparación del IMC medio normalizado por edad en niños y adolescentes y en adultos.



***Notas: Se define niños y adolescentes entre 5 y 19 años y adultos entre 20 años o más. Cada punto representa un grupo de países. La línea de puntos muestra la asociación lineal entre los dos resultados. Fuente: Bentham et al* (3)**

En el caso de España, los estudios parecen indicar el surgimiento de un problema de salud pública asociado a los hábitos de alimentación y estilo de vida. El estudio EnKid observó un incremento del exceso de peso entre la población infantil y juvenil, con una prevalencia de obesidad y sobrepeso de 13,9% y 12,4% respectivamente, lo cual implica que un 26,3% de la población

española entre 2-24 años padece una sobrecarga ponderal[1]. Este panorama, se confirma en población infantil con los estudios ALADINO 2011, 2013 y 2015 los cuales reportaron que el exceso de los niños de entre 7 y 8 años es superior al 40%. Sin embargo, si se utiliza la metodología aplicada en el estudio EnKid el resultado sería de prevalencia de exceso de peso del 31,4% (9). Otros estudios recientes en población infantil y juvenil como el estudio PASOS y el estudio nutricional de la población española muestran tendencias igualmente alarmantes con cifras de prevalencia de exceso de peso que superan el 34%.(10,11) Estos resultados son similares a los reportados por el estudio HELENA donde se halló una prevalencia agregada de sobrepeso y obesidad de un 23.1% en población adolescente (12). A nivel de Cataluña, región donde se realizaron los estudios de la presente tesis doctoral y de acuerdo con la encuesta de salud de Cataluña el 35.6% de la población de 6 a 12 años presenta exceso de peso.(13)

Tabla 1. Prevalencia de sobrepeso y obesidad infantil en España

Estudio	Año	Edad (años)	Metodología	Resultados
Estudio EnKid (14)	1998-2000	8 a 13	Datos medidos	31,2 % de exceso de peso • 14,6% sobrepeso • 16,6% obesidad
		14 a 17		21,8 % de exceso de peso • 9,3% sobrepeso • 12,5% obesidad
Sánchez-Cruz (15)	2012	8 a 13	Datos medidos	24,0 % de exceso de peso • 9,3% sobrepeso • 14,7% obesidad
		14 a 17		20,3 % de exceso de peso • 8,2% sobrepeso • 12,1% obesidad
ALADINO (AESAN) (9,16,17)	2011	6 a 9	Datos medidos	44,5 % de exceso de peso • 26,3 % sobrepeso • 18,3 % obesidad
	2013			43,0 % de exceso de peso • 24,6 % sobrepeso • 18,4 % obesidad
	2015			41,3 % de exceso de peso • 23,2 % sobrepeso • 18,1 % obesidad
Thao (18) (resultados último corte transversal)	2015	3 a 5	Datos medidos (estudio longitudinal)	19,6 % de exceso de peso • 14,2 % sobrepeso • 5,4 % obesidad
		6 a 9		29,0 % de exceso de peso • 20,7 % sobrepeso • 8,3 % obesidad
		10 a 12		29,8 % de exceso de peso

[1] Estas estimaciones están basadas en la definición de sobrepeso como valores del Índice de Masa Corporal (IMC: relación entre peso en Kg/altura en metros cuadrados) comprendidos entre percentiles 85-97 (específicos por edad y sexo) de los valores de referencia de las tablas de Orbegozo y la obesidad con valores de IMC iguales o mayores al percentil 97.

				• 24,0 % sobrepeso • 5,8 % obesidad
Estudio Nutricional de la Población Española (ENPE)(11)	2015	3 a 8	Datos medidos	39,8 % de exceso de peso • 23,9 % sobrepeso • 15,9 % obesidad
		9 a 18		34,0 % de exceso de peso • 22,4 % sobrepeso • 11,6 % obesidad
Observatorio OMS(19)	2016	5 a 19	Datos medidos	34,1 % de exceso de peso • 23,3 % sobrepeso • 10,8 % obesidad
Encuesta Nacional Salud en España (MSCBS)(20)	2017	2 a 17	Datos auto-referidos	28,6 % de exceso de peso • 18,3 % sobrepeso • 10,3 % obesidad
PASOS (10)	2019	8 a 16	Datos medidos	34,9 % de exceso de peso • 20,7 % sobrepeso • 14,2 % obesidad

Notas: Los datos de sobrepeso y obesidad son bajo los criterios internacionales de la OMS

Este incremento en la prevalencia en obesidad está correlacionado con el deterioro de los patrones de alimentación saludable y la falta de la actividad física (21–23). En efecto, hábitos de alimentación inadecuados como el consumo elevado de bollería, bebidas azucaradas y zumos de frutas, embutidos, entre otros son factores que predisponen a un incremento del peso (21,22). En España estás tendencias se refleja en la reducción de la adherencia a la dieta mediterránea (DM) dentro de la población en edad escolar (24–27). La DM ha sido definida como la combinación de hábitos de alimentación y múltiples dimensiones socio-culturales de la población de los países de la cuenca mediterránea (28–30). Bajo este patrón de alimentación, predomina el consumo controlado de cereales, legumbres, frutos secos, pescado y aceite de oliva, reduciendo significativamente la ingesta de carnes rojas y comida procesada (30).

Diversos estudios han mostrado que, en España, entre el 46.7% y 69.1% de los niños y jóvenes (2 a 24 años) requieren mejorar su hábitos de alimentación para lograr una adherencia óptima a la DM (24,26). Estos resultados son similares a los encontrados en otros países como Italia, Grecia y Turquía (24,32–34,36). Adicionalmente, la Encuesta Nacional de Salud 2011-12 encontró que una alta adherencia a la Dieta Mediterránea está inversamente relacionada con el perímetro de cintura, lo que podría implicar que con niveles bajos de adherencia a la DM se incremente el riesgo de enfermedades cardiovasculares en niños y adolescentes (31).

Asimismo, la actividad física se ha asociado como estrategia efectiva para reducir la obesidad, al normalizar los niveles de las hormonas involucradas en la saciedad en adolescentes y niños obesos (38). En el caso Español, el estudio EnKid pone de manifiesto que alrededor del 70% de niños y adolescentes españoles, no realiza actividad física de forma regular en su tiempo libre (39). De

acuerdo con la Encuesta Nacional de Salud de España 2017-18 más del 30% de la población en edad escolar no cumplen con las recomendaciones de la OMS sobre actividad física, y cerca del 73% tampoco lo hacen para el uso de pantallas en el tiempo libre.(20) A nivel regional, los resultados de la encuesta de Salud de Cataluña (ESCA) (2018) indican un panorama similar al resto de España, y además se observa que las niñas tienen valores inferiores en la práctica de actividad física que los (13).

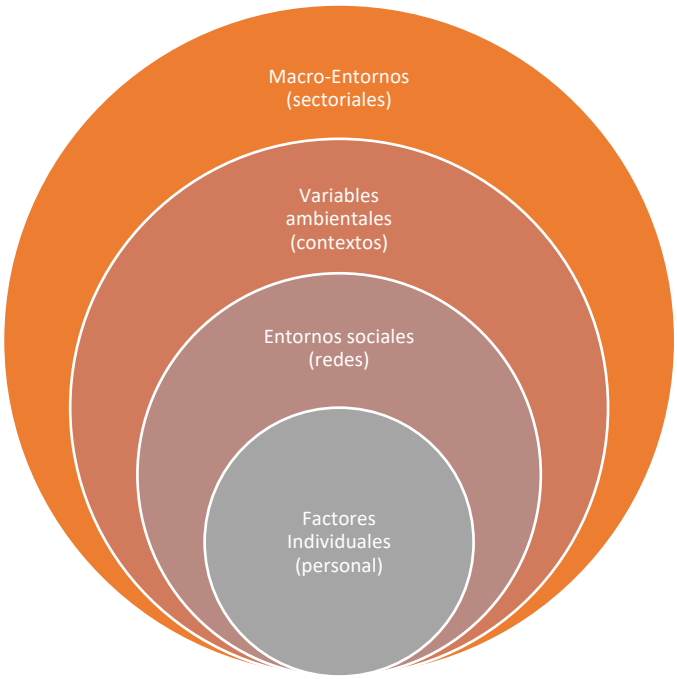
Ante estos resultados, la población de niños y jóvenes se convierte en un foco fundamental de intervención para generar transformaciones conductuales que instauren de manera definitiva estilos de vida y patrones de alimentación saludables (40). Además entender los factores que facilitan u obstaculizan la adopción de pautas dietéticas y estilos de vida saludables en esta población se convierte en un elemento central para la salud pública (7,41,42).

En la literatura, existe evidencia sobre los factores que se asocian con la adherencia a patrones de alimentación saludable, entre estos se destacan: i) factores socioeconómicos y demográficos como la composición de la familia, los ingresos financieros y la educación de los padres (26,33,43–46); ii) la participación en actividades físicas regulares (23,41,47,48); y iii) la participación en actividades sedentarias tanto en la escuela como fuera de ella (33,49–51). Tradicionalmente estos últimos factores individuales y de orden psicológico han sido mencionadas como los principales determinantes del estilo de vida en dicha población (52) y como consecuencia, diversos programas de intervención se han basado en promover cambios conductuales en los jóvenes y niños, bajo el precepto de *comer menos y moverse más* (53–55). Esta visión asume que el individuo se desenvuelve en entornos neutrales que no generan influencias en sus hábitos, dejando de lado la compresión de aspectos como los micro-entornos (la infraestructura de las escuelas, los componentes situacionales, entre otros) y los macro-entornos (legislación, marketing, entre otros) en los que se halla inmerso el sujeto, los cuales pueden facilitar u obstaculizar la adopción de hábitos saludables en edades tempranas (55–59). Es decir, las decisiones sobre los patrones de alimentación y estilo de vida serian el resultado de un interacción compleja y dinámica de múltiples dimensiones de orden individual, social y comunitario que interactúan a favor o en contra de esquemas de comportamiento que favorecen determinados hábitos (53,60).

En este sentido, Story *et al.* (60) ofrecen un marco analítico que permite entender dichas las interacciones en un orden jerárquico y estructurado. Siguiendo un modelo socioecológicoa, estos autores afirman que los patrones de alimentación y estilos de vida están enmarcados por cuatro

dimensiones: (i) macro-entornos; (ii) variables ambientales; (iii) entornos sociales; y, (iv) factores individuales (Figura 2).

Figura 2. Modelo socioecológico sobre los entornos alimentarios para los patrones de alimentación y estilos de vida



Fuente: El diagrama es una modificación del presentado por Story et al. (60)***.***

El primer nivel, el cual abarca las demás categorías encontramos los *macro-entornos* los cuales hacen referencia a las políticas públicas nacionales, marcos regulatorios, normas sociales generales, sistema económicos, sistemas de salud, estructura de uso de la tierra, redes de transporte, entre otros (60). A nivel productivo, este entorno brinda las condiciones para la creación de las cadenas productivas agro-alimentarias y de los mecanismos de establecimiento de precios de los alimentos al generar un marco normativo sectorial que incluye producción, distribución y venta final de alimentos en la sociedad (52). Asimismo, contienen la presencia o ausencia de marcos regulatorios nacionales que promueven la salud pública, a través de políticas públicas las cuales de manera directa (por ejemplo, los subsidios) o indirecta (por ejemplo, la publicidad) pueden favorecer el interés general de la población (52).

Posteriormente, condicionado por las características estructurales que establecen los macro-entornos, se encuentra las variables ambientales, las cuales hacen referencia a los contextos físicos y organizacionales en los cuales los individuos desarrollan de manera diaria sus hábitos de alimentación y estilo de vida (60). Esta dimensión incluye el contexto que influye de manera directa

en las decisiones individuales al imponer barreras o facilitar el acceso de los individuos a ambientes propicios donde obtener opciones saludables de alimentación (61,62). Esta dimensión se puede agrupar en cuatro entornos: (i) *entornos de alimentación comunitario*, los cuales hacen referencia a los tipos, localización y accesibilidad a los establecimientos ; (ii) *entorno de consumo*, los cuales hacen referencia al tipo de oferta alimentaria dentro los establecimientos, la información nutricional disponible en las tiendas, entre otros; (iii) *entornos organizacionales*, que hace referencia al acceso a los alimentos y aplicación políticas o normas en sitios como el lugar de trabajo, escuela, el hogar, entre otros; (iv) *entorno informacional*, que hace referencia al tipo de publicidad e información relacionada con la alimentación que se recibe en el contexto (53).

En el tercer nivel se encuentran los entornos sociales, los cuales se basan el tipo de relaciones sociales que tienen el individuo con su familia, amigos, compañeros de escuela y otras personas que forman del circulo social del individuo (60). Este entorno busca reconocer la importancia de la dimensión psico-social del individuo a través de reconocer que el grupo social al cual pertenece determina los modelos a seguir, las redes de soporte social y en general las normas sociales que pueden dar forma a los hábitos de vida y consumo (63,64).

Finalmente, se encuentra los factores individuales que se asocian a las características psicológicas, genéticas y metabólicas del individuo. Aspectos relacionados con la autoestima, niveles de ansiedad, la auto-imagen, entre otros aspectos de orden psicológicos han sido asociados tradicionalmente como aspectos determinantes en la toma decisiones saludables entre la población (65–67). Asimismo, desordenes de carácter físico relacionados con alternaciones genéticas y/o enfermedades metabólicas pueden pre-condicionar la probabilidad de que algunas personas adopten unos patrones de alimentación saludable (68).

En la práctica, es difícil identificar cuál de estas dimensiones será el factor determinante para garantizar el éxito o el fracaso de una intervención o política enfocada a promover entornos saludables en la población, especialmente, entre niños y jóvenes (53,69). En un escenario ideal, el diseño y evaluación de los efectos de estas intervenciones deberían incluir diseños multi-nivel donde se involucren las interacciones y variables de las cuatro dimensiones (70). No obstante, la falta consenso sobre los marcos analíticos para entender la dinámica y mecanismos causales a través de los cuales las diferentes dimensiones se retroalimentan (55,59,63), ha producido que la investigación de los diferente entornos alimentarios se omita o se mencione de manera marginal (55,71,72).

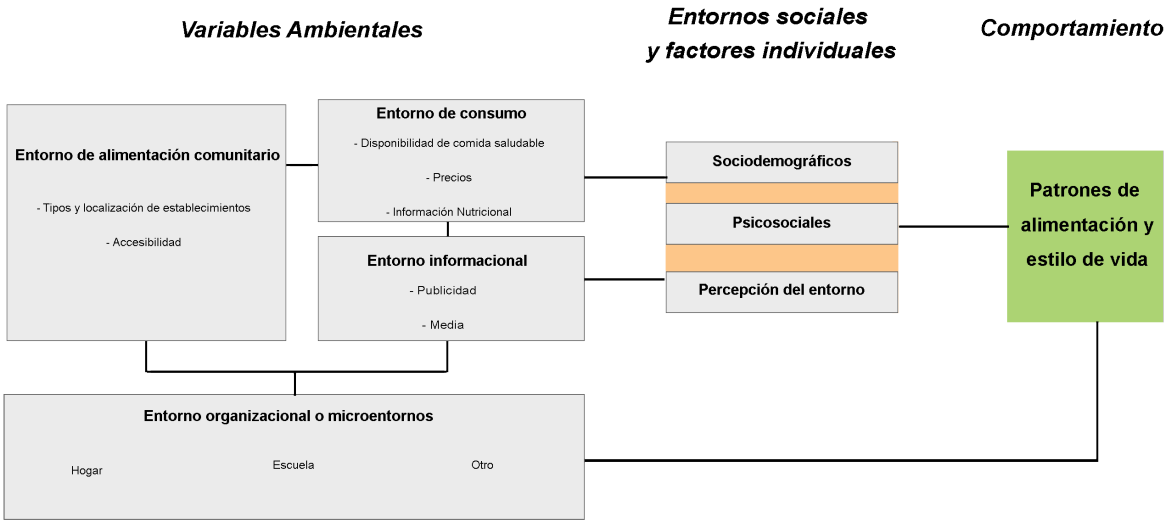
La necesidad de marcos analíticos y metodológicos que permitan entender las dinámicas e interacciones es particularmente apremiante en el análisis de las variables ambientales (*entornos de alimentación comunitario, entorno de consumo, entornos organizacionales y entorno informacional*), ya que constituye la dimensión con menos investigación disponible y es el lugar donde las intervenciones podrían tener mayor impacto en la formación de hábitos saludables, en especial, en los niños y jóvenes en edad escolar (53,72–74). Por ejemplo, las intervenciones dentro de los entornos escolares dirigidas a mejorar los hábitos de alimentación y de actividad física se han convertido en una de las estrategias más exitosas en las intervenciones sobre esta población (53). En este sentido, la comprensión de los mecanismos a través de los cuales las variables ambientales modifican la formación de hábitos en la población escolar se establece como una prioridad para los estudios de salud pública (75,76).

De acuerdo a revisiones sistemáticas de literatura recientes, uno de los principales aspectos que podría explicar la ausencia del estudio de las variables ambientales en investigaciones y en los sistemas de diseño, seguimiento y evaluación de intervenciones nutricionales es la ausencia de herramientas estandarizadas, validadas, de fácil acceso y bajo costo que estudien esta dimensión (53,55,72). Este hecho es particularmente crítico en los estudios para niños y jóvenes (57,77–79). En el caso de España, más allá de algunos estudios de caso que utilizan cuestionarios auto-reportados, esta falencia está presente (80–82).

Las variables ambientales podrían afectar la adopción de patrones de alimentación y estilos de vida saludable de los niños y jóvenes a través de dos mecanismos. En primer lugar, pueden acentuar o mediar los efectos que tienen los factores individuales como los sociodemográficos, psico-sociales y de la percepción del entorno sobre los estilos de vida. En segundo lugar, pueden influir de manera directa, al marcar el contexto de oferta y acceso en el cual los niños y jóvenes toman sus decisiones con respecto a la alimentación y estilo de vida (52,53).

Siguiendo el modelo sistémico de Glanz *et al.* (53), la Figura 3 resume las interacciones de los diferentes entornos y su rol en la formación de patrones de alimentación y estilos de vida en la población. Este modelo no solo permite entender las interrelaciones de los diferentes entornos, sino que pone en manifiesto las especificaciones metodológicas que son necesarias para realizar una aproximación conceptual adecuada. Los macro-entornos asociados a las variables gubernamentales y de políticas públicas son omitidos en el esquema para simplificar el análisis.

Figura 3. Modelo de los entornos alimentarios y la adopción de hábitos saludables en población en edad escolar



Fuente: el diagrama es una adaptación del esquema presentado por Glanz et al (53)***.***

El primer entorno que juega un papel importante en la adopción de hábitos saludables en población en edad escolar es el *entorno comunitario*, el cual hace referencia al número, tipo, localización y accesibilidad de los diferentes establecimientos comerciales que tiene algún tipo de oferta alimentaria (supermercados, restaurantes, comidas rápidas, entre otros) alrededor de los sitios donde esta población permanece la mayoría parte del tiempo, como serian el hogar o la escuela (53,70). En la actualidad, existe un número creciente de evidencia empírica sobre la relación de *entorno comunitario* con las decisiones relacionadas con la salud y hábitos saludables (83,84). Los cambios en los patrones de consumo de la sociedad, el cambio en los modelos de producción alimentaria, el incremento de la desigualdad económica, entre otros factores, han configurado nuevos contextos que propician hábitos de alimentación no saludables (84–86).

A nivel metodológico, a pesar de la múltiple evidencia cualitativa que muestra la relación entre los entornos comunitarios y los hábitos de vida, aun existe una importante necesidad de medir su relación causal e impacto en la población de edad escolar (53,84–86). En efecto, revisiones sistemáticas de literatura han encontrado poca evidencia cuantitativa sobre esta relación, encontrando en su mayoría resultados nulos (85,86). Según McKinnon *et al.* (87) y Lytle *et al.* (88) una de las principales razones de estos hallazgos es la falta de métodos de recolección de información validados y estandarizados que permitan medir de manera clara y sistemática los entornos comunitarios alimentarios.

La segunda variable ambiental es el entorno *de consumo*, el cual está intrínsecamente relacionado con el *entorno de alimentación comunitario*. Este entorno hace referencia al tipo de oferta alimentaria dentro de los establecimientos comerciales y otros contextos donde los niños y jóvenes consumen algún tipo de alimentos (53). En este sentido, en este entorno se incluye las composiciones nutricionales de los alimentos, los precios de los productos, los rangos de opciones, la localización de los alimentos dentro de los establecimientos, entre otras características que definen la calidad del consumo que pueden tener los individuos (53). La evidencia demuestra que intervenciones dentro de los supermercados ofrecen resultados positivos en las decisiones de compra que afectan a los patrones de alimentación de los individuos. Estrategias como promociones, bonos monetarios, re-localización de productos en estantes, campañas informacionales con marquillas, entre otras actividades en el interior de los establecimientos con oferta de alimentos, se convierten en una nueva oportunidad de intervención pública (89,90). Esta oportunidad se presenta también dentro restaurantes donde la composición de los menús, tamaño de porciones, la presencia de alimentos ultra-procesados, entre otros factores puede convertirse en un área de intervención (52,53).

Desde el punto de vista de recolección de información, se requiere una revisión detallada y descriptiva de la oferta al interior de los establecimientos producto por producto (91,92). Teniendo en cuenta lo anterior, el entorno de consumo se convierte en uno de los entornos con mayor demanda de información y dificultades en la recolección de información dada la complejidad y los requerimientos. En la actualidad existen diversos instrumentos que han tratado de estandarizar y facilitar la recolección de este tipo de información, herramientas como la *Nutrition Environment Measure Survey* (NEMS) ofrecen alternativas viables para la inclusión de este entorno en el estudio de la población de niños y jóvenes (61). Desafortunadamente, la alta exigencia de información requerida para su análisis y la complejidad que implica han hecho que este entorno sea olvidado entre las diferentes intervenciones y análisis de programas de salud pública en población escolar (91,92).

El tercer entorno que componen el modelo de variables ambientales es el *entorno informacional*. Este aspecto recoge la exposición a información relacionada con productos de alimentación la cual está orientada a modificar las preferencias sobre algunos alimentos de los niños y jóvenes (93,94). Este entorno tiene componentes que parten de los macro-entornos a partir de las políticas de información de la industria alimentaria nacionales y regionales, así como de estrategias informacionales orientadas a contextos locales como son los barrios e incluso el interior de los

hogares (53). Los resultados empíricos muestran que existe una relación positiva entre la exposición a la publicidad en la televisión y videojuegos y el consumo de alimentos en población en edad escolar (2 a 14 años) (94). En contraste, proveer al consumidor de información adicional sobre la composición de los alimentos como la presencia de alto contenido de azúcar y grasa, se ha desvelado como una estrategia que aumenta el nivel de conciencia sobre la elección de alimentos, aumentando el consumo de alimentos saludables (93).

Los estudios empíricos sobre este entorno pueden clasificarse en dos tipos de métodos. Primero, están los estudios basados en métodos experimentales, donde los niños y jóvenes son expuestos de manera controlada a diferente información sobre alimentos a través de la publicidad. De este modo, se busca determinar la diferencia en sus preferencias antes y después de la exposición a la información (94). Por otro lado, están los métodos que hacen un análisis detallado del contenido de la información publicitaria de productos en los diferentes medios de comunicación (TV, periódicos) y contextos ambientales a los cuales jóvenes y niños tiene acceso (52,93,94).

Finalmente, la última variable ambiental es el *entorno organizacional* o *micro-entornos*. Esta dimensión hace referencia a los entornos donde los niños y jóvenes permanecen y toman las decisiones sobre los patrones de alimentación, actividad física y demás factores del estilo de vida (53,60). En este sentido, micro-entornos como el hogar, la institución educativa a la que atienden los niños y jóvenes, los grupos extra-escolares, las parroquias religiosas, entre otros están contenidos en esta categoría. Dada su naturaleza, estos entornos son sumamente complejos de estudiar por su alta inter-relación y dinámica con los demás entornos que componen las variables ambientales (60). Entre los diferentes micro-entornos, el hogar ha recibido una atención especial por parte de los investigadores de este campo. La distribución del hogar, los aspectos socio-demográficos del hogar, las prácticas de crianza, las técnicas de cocina, entre otros aspectos han sido estudiados como los principales mecanismos a través del cual el ambiente del hogar puede intervenir en la formación de los patrones de alimentación y hábitos saludables del hogar (95–97).

En comparación con el hogar, los demás micro-entornos donde los niños y jóvenes pasan gran parte del día han recibido relativamente menos atención (41,98). Para la población en edad escolar la institución educativa se convierte en el lugar donde pasan la mayor parte de su vida diaria y donde consumen entre un tercio y la mitad de sus comidas, lo que hace que este micro-entorno sea una influencia crítica para la formación de hábitos saludable (99). En efecto, las intervenciones ambientales y las normativas basadas en el fomento de entornos escolares saludables han sido

identificadas estrategias efectivas para crear mejoras en población en edad escolar en cuanto a la alimentación, la actividad física y el estado de peso (7,79,100). Por lo tanto, es importante comprender las dimensiones y consecuencias que el micro-entorno escolar puede tener en establecer hábitos de alimentación de por vida que influyan en el riesgo futuro de obesidad y enfermedades cardio-metabólicas (75,76).

Al igual que los demás entornos, desde el punto de vista metodológico el estudio sobre los diferentes *micro-entornos* presenta importantes oportunidades debido a la falta de herramientas validadas y estandarizadas. La multiplicidad de estudios sobre el hogar como micro-entorno ha dado como resultado diferentes aproximaciones metodológicas y medidas que en ocasiones carecen de transparencia en las propiedades psicométricas (101). Por su parte, a pesar del incremento del reconocimiento de la escuela como uno micro-entorno a tener en cuenta, existe una baja disponibilidad de instrumentos validados y estandarizados que permitan abordar de manera integral las diferentes dimensiones que incluye la escuela (74).

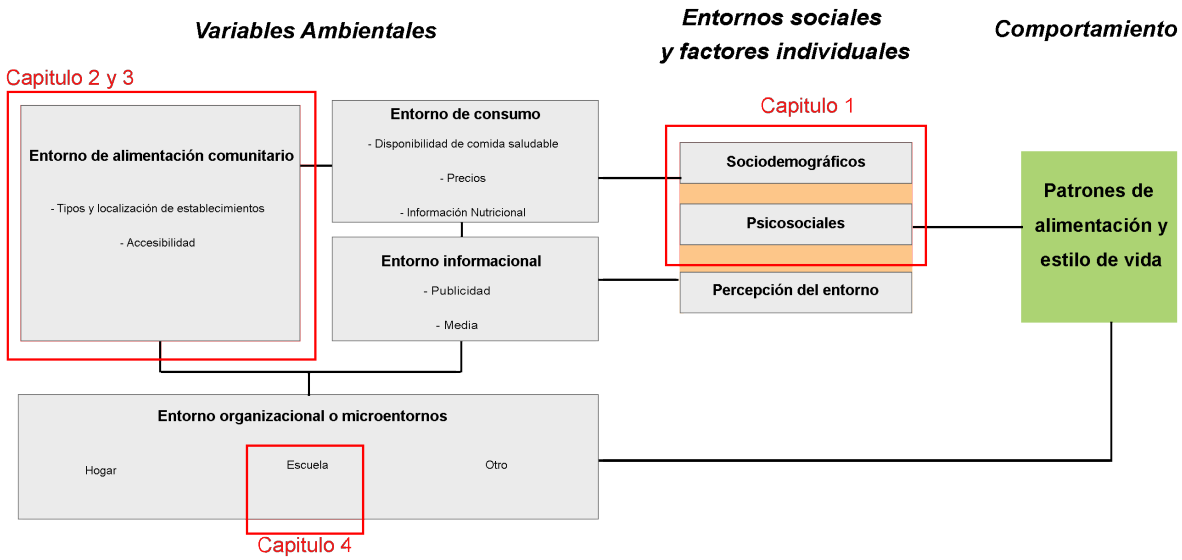
En suma, a pesar de la creciente evidencia sobre la relación entre los diferentes entornos alimentarios y la adopción de hábitos saludables en población en edad escolar, uno de los factores comunes desde el punto de vista metodológico es la carencia de instrumentos validados y fiables para su medición (60). En este sentido, se deben generar nuevos marcos metodológicos que faciliten su estudio e inclusión en los análisis e intervenciones de política pública para promover patrones de alimentación y estilos de vida saludable.

La presente tesis pretende *desarrollar herramientas metodológicas para el estudio de las variables ambientales en población en edad escolar, con el fin de facilitar la comprensión de la relación de estos con la adopción de hábitos saludables*. En el primer capítulo, se parte de una aproximación descriptiva sobre los principales factores individuales y ambientales asociados a la adherencia a patrones de alimentación saludables en una población escolar, usando un estudio de caso para la ciudad de Mataró (España). Este primer estudio, brinda evidencia cuantitativa sobre el peso que tiene los diferentes aspectos del modelo sistémico sobre la adherencia a patrones de alimentación saludables de la población escolar de la ciudad de Mataró.

En los capítulos 2 y 3 se presenta y valida el Facility List Coder – FLC –, una nueva herramienta basada en información geo-localizada secundaria para la evaluación automática de entornos de alimentación a nivel comunitario. Finalmente, el capítulo 4 adapta y valida a la cultura española

una nueva herramienta para evaluar el micro-entrono escolar llamada *School Physical Activity and Nutrition Environment Tool* (SPAN-ET), la cual permite una evaluación integral del entorno de actividad física y nutrición teniendo en cuenta aspectos físicos, situacionales y de política. La Figura 4 resume la contribución de la tesis a partir del modelo sistémico mencionado anteriormente.

Figura 4. Estructura de la tesis a partir del modelo socio-ecológico de entornos alimentarios y la adopción de hábitos saludables en población en edad escolar



II. OBJETIVOS

El incremento de la prevalencia de la obesidad entre población de edad escolar es uno de los principales retos para la salud pública en la actualidad. Tradicionalmente, las dimensiones individuales de orden psicológico han sido mencionadas como las principales determinantes del tipo de patrones de alimentación y de actividad física en dicha población. Como consecuencia, diversos programas de intervención se han basado en promover cambios conductuales en los jóvenes y niños, bajo el precepto de *comer menos y moverse más*. No obstante, esta visión asume que el individuo se desenvuelve en entornos neutrales que no generan influencias en sus hábitos, dejando de lado la compresión de dimensiones como la infraestructura de las escuelas, los componentes situacionales y legislativos que incentivan o no, la practica de actividad física y la elección de alimentos saludables, la oferta alimentaria dentro y fuera de los centros educativos, entre otros factores pueden facilitar u obstaculizar la adopción de hábitos saludables.

En este sentido, la compresión y caracterización de los diferentes *entornos de alimentación* en los que desenvuelven los jóvenes y niños se convierte en un elemento central, para diseñar e implementar intervenciones efectivas que promuevan hábitos saludables que perduren a través de la vida. El tipo y localización de la oferta alimentaria dentro y fuera de la escuela (*entorno comunitario*), las políticas encaminadas a promover hábitos saludables (*entorno organizacional*), la disponibilidad y accesibilidad de opciones saludables (*entorno de consumo*) y el tipo de información que se recibe en los diferentes medios (*entorno informacional*), son los principales entornos que juegan un rol fundamental en la formación de los hábitos de la población en edad escolar.

A pesar de su relevancia, la inclusión de los *entornos alimentarios* en investigaciones y en los sistemas de diseño, seguimiento y evaluación de intervenciones nutricionales en población escolar, presentan un obstáculo debido a la falta de herramientas estandarizadas, validadas, de fácil acceso y bajo costo. La ausencia de un marco metodológico estandarizado no ha permitido tener a disposición indicadores de seguimiento y variables que permitan controlar los potenciales efectos de los entornos en los hábitos saludables de la población escolar.

La **justificación central** de la presente tesis se basó en **que los diferentes entornos alimentarios son un elemento fundamental en la adopción de hábitos saludables en población escolar. En este sentido, es imprescindible contar con un marco metodológico validado y de fácil acceso permita que los investigadores e implementadores de política pública, puedan comprender los mecanismos que obstaculizan o promueven la adopción y permanencia de hábitos saludables a través de la vida en los jóvenes y niños en edad escolar.**

A partir de esta justificación, el objetivo principal de la presente tesis fue:

Desarrollar herramientas metodológicas para el estudio de las variables ambientales en población en edad escolar, con el fin de facilitar la compresión de la relación de los entornos con la adherencia a patrones de alimentación y estilo de vida saludables.

El objetivo general se obtendrá a través de los siguientes objetivos específicos:

OBJETIVO 1: Determinar los principales factores individuales y ambientales asociados a la adherencia a patrones de alimentación saludables en la población escolar de la ciudad de Mataró.

El desarrollo de este objetivo se encuentra publicado en:

- *Determinants of Adherence to Healthy Eating Patterns in a Population of Children and Adolescents: Evidence on the Mediterranean Diet in the City of Mataró (Catalonia, Spain). Nutrients 134 (2012) 1385–91*

OBJETIVO 2: Diseñar y validar una nueva herramienta basada en información geo-localizada secundaria para la evaluación automática de entornos de alimentación a nivel comunitario, con el fin de facilitar el estudio de estos entornos.

Como resultado del desarrollo de este objetivo de diseño el *Facility List Coder* (FLC), cuyos métodos técnicos y metodológicos fueron publicaron en dos artículos:

- "*Validity and Reliability of the Facility List Coder, a New Tool to Evaluate Community Food Environments" at Int J Environ Res Public Health. 2019 Oct; 16(19): 3578*".
- *"Introducing the Facility List Coder: A New Dataset/Method to Evaluate Community Food Environments". Data, 2020. 5(23):*

OBJETIVO 3: Adaptar y validar al entorno socio-económico y cultural español una nueva herramienta para evaluar el micro-entorno escolar que incluya los aspectos físicos, situacionales y de política asociados a la adopción de hábitos de alimentación y de actividad física saludables.

El desarrollo de este objetivo se centró en la validación de la herramienta *School Physical Activity and Nutrition Environment Tool* (SPAN-ET), cuyos resultados se encuentran en el siguiente manuscrito:

- *Cross-Cultural Adaptation, Content Validity and Feasibility of the Spanish Version of School Physical Activity and Nutrition Environment Tool – SPAN-ET- (en revision)*

III. RESULTADOS

Artículo 1: Determinants of Adherence to Healthy Eating Patterns in a Population of Children and Adolescents: Evidence on the Mediterranean Diet in the City of Mataró (Catalonia, Spain)

Ana Maria Arcila-Agudelo, Carmen Ferrer-Svoboda, Teresa Torres-Fernández and Andreu Farran-Codina

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Categoría (posición, cuartil): Nutrition & Dietetics -- SCIE (16/87, Q1)

Resumen

Objetivo: Analizar los factores determinantes que se asocian con la adherencia óptima a la dieta mediterránea en la población escolar de la ciudad de Mataró, España.

Materiales y métodos: Se llevó a cabo un estudio observacional descriptivo de tipo transversal en 18 escuelas seleccionadas aleatoriamente en la ciudad de Mataró, España. Un total 1177 niños y adolescentes entre los 6 y 18 años de un total de 42 escuelas de la ciudad participaron del estudio. Los datos se obtuvieron por medio de una encuesta que indagaba sobre diferentes aspectos del estilo de vida, socio-demográficos, económicos y de salud. Para evaluar la adherencia a la dieta mediterránea se utilizó el índice KIDMED, a partir del cual se construyó una variable dicotómica que valoraba la adherencia a un patrón de dieta mediterránea óptimo. El análisis de los datos se realizó a través de un modelo de regresión logística.

Resultados: El 59% de los participantes del estudio presentaron una adherencia sub-óptima a la dieta mediterránea. Esta prevalencia fue más alta en los jóvenes de secundaria (70%) que en los niños de primaria. Los factores positivamente asociados con una adherencia óptima a la dieta mediterránea fueron: (i) el nivel de educación de la madre (OR = 1.89; 95% CI: 1.35–2.63); (ii) estar cursando la primaria (OR = 1.84; 95% CI: 1.05–3.23); (iii) la ausencia de distracciones durante el desayuno(OR = 1.39; 95% CI: 1.06–1.81); y por último, (iv) la actividad física regular vigorosa (OR =1.09 95% CI: 1.01–1.19) y ligera (OR=1.08 95% CI: 1.01–1.15). La disponibilidad de dinero para comprar en la escuela/instituto presentó una asociación negativa con la probabilidad de adherencia óptima a la dieta mediterránea (OR= 0.74 95% CI: 0.57–0.97). No se encontró asociación entre una dieta mediterránea óptima y variables tales como: la educación del padre, el tipo de escuela/instituto (público o privado), el índice de masa corporal, la escala de riqueza familiar y el lugar de procedencia de la madre.

Conclusiones: Los resultados obtenidos sugieren que la implementación de cualquier intervención encaminada a la adopción de hábitos saludables, como la adherencia a la dieta mediterránea, deberían incluir la participación de los padres especialmente aquellos con bajos niveles de educación. De igual modo, la población adolescente deberían ser un foco fundamental de dichas intervenciones. Considerando la posible influencia de la disponibilidad de dinero en relación con las oportunidades de adquisición de comida saludable, se destaca como el entorno

comunitario se convierten en un factor a considerar para garantizar el éxito de las intervenciones en la población de edad escolar.

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Article

Determinants of Adherence to Healthy Eating Patterns in a Population of Children and Adolescents: Evidence on the Mediterranean Diet in the City of Mataró (Catalonia, Spain)

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Abstract: Despite its benefits, the Mediterranean diet (MD) is being abandoned or not adopted by young generations in most Mediterranean countries. In Spain, up to 69% of the child and adolescent population has been found to have suboptimal adherence to the MD. The aim of this study was to analyze which factors are associated with an optimal adherence to the MD in school-age children and adolescents from Mataró, Spain. A cross-sectional study was performed on 1177 children and adolescents aged between 6 and 18 years from Mataró. The Mediterranean Diet Quality Index for Children and Adolescents (KIDMED index) was used to evaluate adherence to a MD. We found that over 59% of subjects showed suboptimal adherence to a MD, with this prevalence being higher for secondary school than for primary school children. The factors positively associated with following an optimal MD were the mother's education level, children at the primary school level, the absence of distractions at breakfast, and regular physical activity. The availability of spending money was negatively associated with the likelihood of optimal adherence to a MD. Future research should study more in-depth the possible causality between the factors studied and adherence to a MD.

Keywords: healthy eating patterns; Mediterranean diet; children; adolescents; KIDMED

1. Introduction

Globalization has led to a rise in the so-called "Western" dietary pattern, characterized by the presence of foods with high quantities of refined carbohydrates, sugars, salt, saturated fats, trans fats, animal proteins, and artificial coloring and flavoring [1]. In contrast to this trend, there remain other traditional dietary models considered highly beneficial to health, such as the Mediterranean diet (MD). This diet has been defined as a combination of dietary habits along with several sociocultural elements of the populations of the countries in the Mediterranean region [1–3]. In this dietary pattern, the consumption of cereals, legumes, nuts, fish, and olive oil predominate, and there is a low intake of red meat and processed foods. Other elements of interest linked to the MD include frugality and moderate to high levels of physical activity [3].

Multiple studies have suggested that a high degree of adherence to the MD is associated with a lower risk of several types of chronic and degenerative diseases, in turn increasing life expectancy and

quality of life [4–10]. Despite these benefits, the MD is being abandoned or not adopted by young generations in most Mediterranean countries [11–14]. In Spain, up to 69% of the child and adolescent population has been found to have suboptimal adherence to the MD [11,15,16]. Similar percentages have been found in this segment of the population in countries such as Greece and Turkey [5,11,17]. In a recent study from northern Italy, an even bigger result was found, with over 80% of school-age children and adolescents having a suboptimal adherence to the MD [18]. This phenomenon has created a "nutritional transition", where problems such as being overweight, obesity, and diet-related chronic diseases have become new challenges for public health systems in Mediterranean countries [13].

Under this scenario, understanding the factors associated with adherence to healthy dietary patterns and lifestyles in a school-age population is essential for an appropriate, focused design of public health interventions that will contribute to early adoption of healthy habits to reduce the impact of this nutritional transition [19–21]. Among the different factors studied for their possible association with whether or not children and adolescents follow a healthy diet have been (i) socioeconomic and demographic factors such as family composition, financial income, and parents' education [16,17,22–25]; (ii) participation in regular physical activity [20,26–28]; and (iii) participation in sedentary activities both at school and outside of school [17,29–31]. As most of these results have focused on adolescents rather than children, there has been a lack of studies that have simultaneously investigated both populations, children and adolescents, and which factors might be associated with their adherence to the MD [32,33]. Thus, this study aimed to analyze the main common determinants of an optimal MD adherence in children and adolescents from Mataró, one of the largest cities in Catalonia, Spain.

2. Materials and Methods

2.1. Participants and Sampling

This study was carried out in the city of Mataró, which is a coastal city located near Barcelona (25 km) in Catalonia, Spain. The city has experienced an important increase in population in the last 50 years (from 40,407 inhabitants in 1960 to 122,905 in 2010) due to migration from other parts of Spain and, in recent years, from other nations (mainly from Morocco). Nowadays, 16.9% of the population is of foreign origin. The economy of Mataró is mainly based on services (63% of total invoicing) and industry (31%) [34]. Populations in the Mediterranean region have experienced an intense urbanization in the second half of the 20th century, and now two-thirds of the Mediterranean population are living in urban areas (>10,000 inhabitants) [35]. Based on the number of inhabitants, Mataró could be considered an average Mediterranean city.

The study population included children and adolescents aged between 6 and 18 years in 2011 from educational institutions in Mataró. Education centers in the city could be state schools (full public financing) or state-sanctioned private schools (mixed public and private financing). In total, there were 42 schools (64.3% public, 35.7% mixed) distributed into three categories and types: (i) Those with only a primary education level (17 public, 1 mixed); (ii) those with a primary and secondary education level (3 public, 12 mixed); and, (iii) those with only secondary school (7 public, 2 mixed). To obtain a representative sample of this population, we used a stratified random sampling method where the strata were the school type (i.e., public and mixed), within which we assumed that the students were a homogeneous group. First, from the universe of institutions, 18 schools were randomly chosen (43% of total schools), from which 11 were public (61.1%) and 7 were mixed (38.9%). Only two schools rejected participation in the study, and they were replaced by other randomly selected schools. According to the type of school, we interviewed 13 institutions with primary level education (40%) and 12 institutions with a secondary level (50%). Then, random samples were obtained for each stratum. In total, 668 primary school students aged 6 to 12 and 509 secondary school students aged 12 to 18 were interviewed, giving a total of 1177 children and adolescents from all of the schools sampled in the city. This sample of 17% of the total school population (n = 7045) constituted a representative sample of the population, with a 95% confidence interval and a margin of error of 2.66%. Data collection took place

between January and October 2011. Sampling weights were not used because the sampling design was a complete randomness sample where all individuals had the same probability of being selected.

All subjects gave their informed consent for inclusion before they participated in the study. The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Bioethics Committee of the University of Barcelona (IRB00003099).

2.2. Data Collection Instruments

To assess adherence to the MD, we used the Mediterranean Diet Quality Index for Children and Adolescents (KIDMED index), which is designed to assess this construct in a population of children and young people aged 2 to 24 years [16]. This index is determined from a 16-point questionnaire that assesses various dietary habits. Each answer is scored according to whether or not it is consistent with habits associated with the MD pattern, and scores are added up to demonstrate the total index of the subject's adherence to the MD. The KIDMED index ranges from −4 (no adherence to the MD) to 12 (complete adherence to the MD). This index is then used to classify subjects into three categories according to their adherence to the MD. Originally, these categories were "very low" adherence to the MD (−4 to 3 points), "need to improve" (4 to 7 points), and "optimal" (8 to 12 points). In order to evaluate additional dimensions related to dietary habits and lifestyle, we applied a questionnaire based on the enKid study [36]. The intensity and type of physical activity was assessed using selected questions from the 1992–2003 Nutritional Survey of the Catalan Population (ENCAT) [37]. The section on socioeconomic factors was based on the Family Affluence Scale (FAS) [38,39]. Basic anthropometric data were collected by following the International Standards for Anthropometric Assessment (ISAK) protocol [40]. Participants' weight was determined by using a Seca brand digital flat scale (Model 813) with a capacity of up to 200 kg and a precision of 100 g. Height was determined using the Seca stadiometer for mobile height measurement (Model 217), which has a maximum capacity of 205 cm and a precision of 1 mm (Seca GmbH & co., Hamburg, Germany).

The anthropometric variables were weight and height, from which the body mass index (BMI) was calculated (weight in kilograms divided by the square of height in meters). In order to estimate the *z*-score (a measure of how many standard deviations below or above the population mean a raw data point is), we used validated reference tables elaborated for Spain [41]. The sociodemographic variables used were sex, age, school level, parents' educational level, parents' place of birth, and availability of spending money at school (yes/no). The variables related to dietary habits were the presence of distractions during mealtimes, eating meals with company, and the presence of vending machines in school. The variables related to other habits and lifestyles were adequate hours of sleep according to the World Health Organization (WHO) (10 h for children and 8 h for adolescents) and frequency of physical activity per week, with a distinction between light and vigorous physical activity. All habits and lifestyle variables were treated as dichotomous variables (yes/no).

2.3. Data Collection Procedure

The schools selected in the random sampling were contacted, and an appointment was made with the principal or educational coordinator in each school to explain the study aims and requirements. We also gave an informative talk aimed at the students in the higher grades to encourage them to take part in the study and give them the chance to ask questions. In addition, each student in the sample was given an explanatory letter about the study and an informed consent form. For primary school, children took the consent form with them in order to have it signed by their parent/guardian, and they returned them within the specified time frame. In the case of high school students, the consent was signed by them inside the classroom and by their parents at home, and then was returned in printed format. Regarding the questionnaires, children from primary school took them in printed format, and then they were completed by their parents at home and returned within the corresponding period. The questionnaires were completed by the mother (72%), by both parents (10%), or by the father (9%). The high school students completed the questionnaires themselves inside the classroom, always

helped by a senior researcher or a student of Human Nutrition and Dietetics or Physiotherapy, who were available to address doubts.

The data from the questionnaire and anthropometric tests were collected by a group of students in the later years of their studies for their Human Nutrition and Dietetics and Physiotherapy degrees: They had received training to carry out the assigned tasks. The procedure of taking anthropometrical measures took place in the school on the days that students had physical education classes. All collected data were entered in a preformatted spreadsheet and then checked for typing errors.

2.4. Statistical Analysis

Differences between groups were compared using Student's *t*-test and a one-way ANOVA. For the purpose of analyzing factors associated with an optimal adherence to the MD according to the KIDMED score, the categories "very low" and "need to improve" were grouped, and a dependent binomial variable was generated in order to perform a multivariable logistic regression analysis of factors associated with following an optimal MD. The odds ratios (OR) were estimated, with 95% confidence intervals (95% CI) and a significance level of 5% ($p \leq 0.05$). Among the factors possibly associated with adherence to the MD, we first considered dietary habits by including the presence of distractions (e.g., television) during main meals (i.e., breakfast, lunch, and dinner) and whether the child or adolescent was used to eating any of those meals alone. Second, we included a dichotomous variable indicating whether a child had the recommended adequate hours of sleep (i.e., the presence of healthy sleep habits) as a proxy for lifestyle. Third, we studied the association between MD adherence and physical activity by including the weekly frequency of vigorous and light physical activity. Fourth, to study socioeconomic aspects, we included whether the mother had been born outside of Catalonia, if the parents had accomplished a higher education level, and the FAS. Fifth, we explored what association the presence of vending machines at school as well as the availability of money at school had with the likelihood of following an optimal MD, if any. Furthermore, we included a set of confounding factors that had been well established in the literature to influence MD adherence: In particular, we considered school year, age, and body mass index [42,43].

3. Results

Participation rates were as follows. The absolute contact rate (the proportion of participants and nonparticipants to total eligible subjects) was 98.9% (98.6% in primary and 99.3% in secondary), a really high figure thanks to the collaboration of schoolteachers. The absolute cooperation rate (the proportion of participants to total subjects contacted) was 78.5% (80.8% in primary and 75.6% in secondary). The absolute response rate (the proportion of participants to total eligible subjects) was 77.6% (79.6% in primary and 75.1% in secondary). Table 1 contains the sample characteristics. Of the whole sample, 47% were male (46% of primary school students and 48% of secondary school students). Participants' ages were between 6 and 18 years, with a mean age of 8.7 years for primary school students, whereas according to local statistical data the average age for the entire population of primary school students from Mataró is 8.4 years and 14.6 years for secondary school students [34], while the average for the entire population of secondary school students is 14.1 years. Regarding anthropometric characteristics, in primary school children, both boys and girls had a mean height of 1.32 m and a mean weight of 31.8 kg. The mean height and weight for secondary school girls was 1.59 m and 53.7 kg, respectively, while for boys, mean height was 1.67 m and mean weight was 56.3 kg: These differences were statistically significant.

Table 1. Description of the main characteristics of the sample of primary and secondary school groups according to sex [1].

	Primary			Secondary		
	Total (*n* = 668)	**Male (*n* = 310)**	**Female (*n* = 358)**	**Total (*n* = 509)**	**Male (*n* = 246)**	**Female (*n* = 263)**
	Mean ± SD	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**
Age	8.7 ± 1.7	8.7 ± 1.7	8.6 ± 1.67	14.9 ± 1.9	15.0 ± 1.9	14.9 ± 1.8
Weight (kg)	31.8 ± 9.2	31.8 ± 9.0	31.8 ± 9.5	56.3 ± 12.5	59.1 ± 14.3 *	53.7 ± 9.9 *
Height (m)	1.32 ± 0.11	1.33 ± 0.11	1.31 ± 0.11	1.63 ± 0.09	1.67 ± 0.10 *	1.59 ± 0.07 *
BMI (kg/m^2)	17.7 ± 2.9	17.6 ± 2.7	17.9 ± 3.1	20.9 ± 3.3	20.9 ± 3.5	20.9 ± 3.1
Adequate hours of sleep (%)	62.0	63.0	61.0	62.0	66.0	59.0
Mother completed higher education (%)	27.0 †	29.0 †	26.0	20.0 †	21.0 †	19.0
Father completed higher education (%)	23.0	26.0	20.0	21.0	21.0	21.0
Mother born outside Catalonia (%)	25.0 †	26.0 †	25.0 †	39.0 †	42.0 †	37.0 †
Low FAS (%)	4.7	4.5	4.8	2.8	2.0	3.4
Medium FAS (%)	64.1†	67.8 †	60.9 †	43.0 †	41.1†	44.9 †
High FAS (%)	31.2 †	27.7 †	34.3 †	54.2 †	56.9 †	51.7 †

[1] For each variable, the groups with the same superscript present statistically significant differences (p-value < 0.05). BMI: body mass index; FAS: Family Affluence Scale. * Differences between sexes in each school group; † differences between school groups: total, male, and female.

The mean BMI values were 17.7 for primary school students and 20.9 for secondary school students. Fourteen percent of primary school children had z-score values above two, while only 1% had values below two. In secondary school students, these percentages were 5% and 1%, respectively. As much as 38% of the children and adolescents studied did not meet the minimum hours of sleep recommended by the World Health Organization (WHO). The percentage of fathers with higher education was 23% in the primary school group and 21% in the secondary school group, with no statistically significant differences between the two groups. For mothers, these values were 27% (primary) and 20% (secondary), which represented a statistically significant difference. The percentage of mothers born outside the region of Catalonia was 25% for mothers of primary school children, but this rose to 39% in mothers of secondary school children: The difference between these percentages was statistically significant. According to Mataró statistical data, the percentage of inhabitants born out of Catalonia is 39.1% [34].

Figure 1 shows the results from the answers to the questions in the KIDMED questionnaire. Although there was a similar trend in both primary and secondary school groups, the secondary school group appeared to have a worse adherence to the MD. As can be seen in Figure 1, this was due mainly to the substantial percentage of adolescents who consumed fast food (24%), processed baked goods (24%), or sweets (26%) every day.

In addition, the results showed a low intake of fruit, vegetables, and nuts in children and adolescents. Furthermore, only 38% of primary school students and 34% of secondary school students reported eating a second portion of fruit per day. Likewise, only 23% of children and 21% of adolescents reported eating raw or cooked vegetables more than once per day. The regular consumption of nuts was only 23% in primary school students and 39% for secondary school students.

There was a statistically significant difference in the KIDMED index between primary school girls and secondary school girls, and also between boys and girls in primary and secondary school (Table 2). The difference between the KIDMED index for all primary school students (7.4 ± 0.1) and all secondary school students (6.3 ± 0.1) was statistically significant. However, no significant difference was found between sexes inside each group (primary or secondary school).

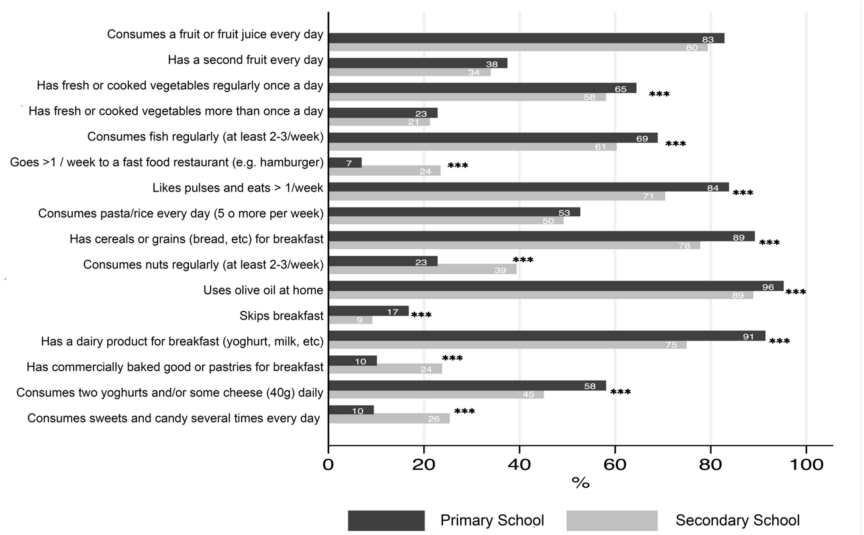

Figure 1. Responses to the questions on the Mediterranean Diet Quality Index for Children and Adolescents (KIDMED index) questionnaire showing the percentage of respondents who gave affirmative answers to each of the 16 questions on the KIDMED questionnaire. *** $p < 0.01$ using one-way ANOVA.

Table 2. Mean scores on the KIDMED index and percentage distribution of the respondents in the three categories of adherence to the Mediterranean diet (MD) (low, moderate, optimal) in accordance with the score obtained on the KIDMED index.

	Primary		**Secondary**	
	Male (n = 310)	**Female (n = 358)**	**Male (n = 246)**	**Female (n = 263)**
	Mean ± SD	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**
KIDMED score	7.4 ± 1.9 †	7.3 ± 1.9 †	6.3 ± 2.3 †	6.3 ± 2.0 †
Distribution by categories of the KIDMED score (%)				
LOW adherence	3.5	2.2	12.6	8.7
MODERATE adherence	45.5	50.8	54.1	64.3
OPTIMAL adherence	51.0	46.9	33.3	27.0

In all of the variables included in the table, the results obtained presented statistically significant differences between the school groups for each sex (p-value < 0.05) according to the Student's t-test (KIDMED score) or the analysis of variance (categories of the KIDMED score). † Differences between school groups for males and females. We did not find any significant differences within gender for each school group.

Table 2 shows the distribution by educational level and sex of the participants into three categories of degree of adherence to the MD, according to the score obtained on the KIDMED index. Without differentiating for sex, the percentage of students who did not have an optimal MD was 59% (51% of primary school students, 70% of secondary school students). Secondary school students had the highest rates of low index scores, as up to 11% of them had a very low-quality MD, while in primary school students, only 3% of children were classified as such.

Figure 2 shows the results of the point estimates for the logistic regression, with the ORs presented in order of magnitude. As explained above, for this logistic model, the variable *KIDMED score* was recodified into two categories: Suboptimal (low and moderate adherence to MD) and optimal. Four factors stood out as being positively predictive of following an optimal MD. First, we observed that children and adolescents whose mothers had completed higher level education were more likely to have optimal adherence to a MD (OR = 1.89; 95% CI: 1.35–2.63). It was also interesting to note that, according to the data obtained in the questionnaire, the mother was responsible for the children's food intake in 66% of primary school students and in 58% of secondary school students, while both mother and father were jointly responsible in 23% and 30% of cases, respectively. Second, with an OR of 1.84, boys and girls from primary school levels were more likely to follow an optimal MD than secondary school students, but with a really wide confidence interval (95% CI: 1.05–3.23). Third, the absence of distractions during breakfast was also a good predictor of optimal adherence to a MD (OR = 1.39; 95% CI: 1.06–1.81).

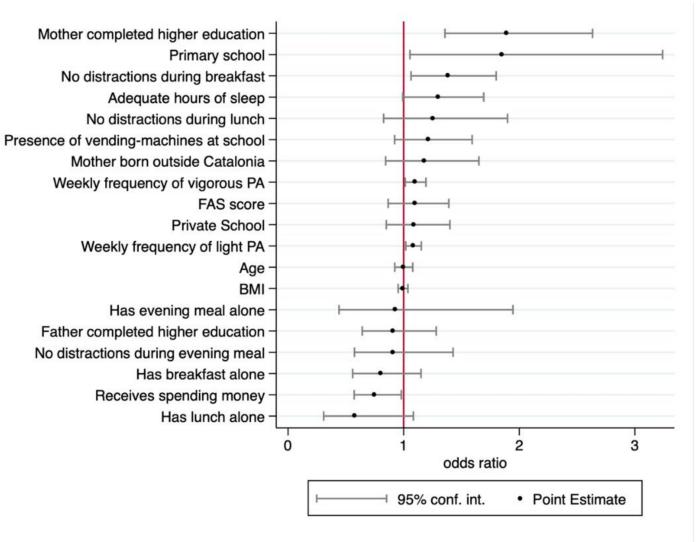

Figure 2. Results of the logistical model for factors associated with optimal adherence to the Mediterranean diet (MD). PA = physical activity; FAS = Family Affluence Scale; BMI: body mass index. The model includes Wald $\chi 2$ (17) = 91.91 (p-value < 0.001).

The last factor that appeared to be positively predictive of optimal adherence to a MD was doing regular physical activity. This variable was divided into two categories: (i) Vigorous, which involves at least 20 min of one of the sports of basketball, football, jogging, gymnastics, aerobics, or physical education class; and (ii) light, which includes walking or riding a bike continuously for at least 30 min, including when the activity is done on the way to school. Both vigorous and light activity were positively associated with optimal adherence to a MD: The OR for the vigorous activity category was 1.09 (95% CI: 1.01–1.19), and for the light category it was 1.08 (95% CI: 1.01–1.15).

The variable "hours of sleep" was divided into two categories (adequate or not adequate) using WHO recommendations (minimum of 10 h for children 6–13 years old and 8 h for adolescents). It should be noted that although hours of sleep did not have a statistically significant association with adherence to a MD, the data indicated some trend in this direction (OR = 1.29; 95% CI: 0.99–1.69; p = 0.05).

Regarding the factors negatively associated with optimal MD adherence, the availability of money to buy food during the school day was the only variable that was statistically significant, with an OR of 0.74 (95% CI: 0.57–0.97). Other factors studied, such as the presence of distractions when eating lunch or the evening meal and eating meals alone, had negative OR values, but these were not statistically significant.

Last, we must point out that there were no statistically significant associations between an optimal MD pattern and the factors of private school, age, BMI, FAS, mother's country of origin, or father's education level.

In order to confirm that overadjustment was not committed, an analysis was performed by running the model variable by variable without adjusting for other variables. This analysis confirmed that both significance and magnitude were consistent with the results of our model, so overadjustment was not present in our results. Thus, we can confirm that our results were robust under different modeling approaches.

4. Discussion

The results for the Mataró school-age population studied confirm the need to improve adherence to the MD pattern in this population: 48.2% of primary school students and 59.2% of secondary school students scored "low" or "moderate" in the adherence categories (and therefore need to improve their diet for adherence to be optimal). The multivariate logistic regression analysis showed a more optimal adherence to a MD in students from primary school levels whose mothers had completed higher education, who did not have distractions at breakfast time, and who regularly did physical activity. The availability of spending money was associated with a lower degree of adherence to a MD.

These figures for MD adherence were similar to those that have been obtained in other previous studies conducted in Spain, which found that in children and young people (2–24 years), between 46.7% and 69.1% needed to improve MD adherence to be considered optimal, respectively [11,16]. Similar percentages have been found for this segment of the population in countries such as Italy, Greece, and Turkey [5,11,17,18,44]. However, there has been significant variability in the figures on MD adherence in children and adolescents in different countries and even within Spain [11,45].

In recent decades, the dietary pattern in Spanish child and adolescent populations has progressively moved away from the MD due to a reduction in the intake of some of the key foods in this dietary pattern, such as fruit, vegetables, legumes, and fish [16,36]. This decline may be due to multiple complex factors that can be grouped into individual determinants (biological factors, preferences, nutritional knowledge, and attitudes) or collective determinants (economic, social, and physical factors) [46,47]. These determinants can interact in different ways.

The logistic regression results identified factors associated with a low adherence to the MD. The mother's education level, but not the father's, was positively associated with the degree of adherence to the MD. These observations coincided with those reported in other studies [12,16,17,22,32], which suggests that decisions regarding the diet of children and adolescents are made mainly by the mother. Mothers with a high educational level can influence the choices their children make by means of the availability and accessibility of certain foods, as well as by being a role model for them. It is also possible that a higher academic status is associated with higher income and consequently greater availability of healthy foods [32]. However, in our case, we did not detect an association between the FAS index and adherence to the MD.

In a study by Serra et al. [16], the authors attributed lower KIDMED index values in lower socioeconomic and educational (mother's education level) strata to a lower consumption of oil, rice, pasta, fruits, and vegetables, suggesting the need to rethink the idea that the MD is inexpensive. Some studies on the financial cost of a MD appear to have pointed to it as having a higher cost compared to the "Western" diet in Spain, a difference that could have become more pronounced during the recent global financial crisis (2008–2012), just when our study was conducted [24]. However, the data from our study showed that a low socioeconomic status, determined using the FAS index,

was not associated with lower KIDMED index values. It is possible that an association was not detected due to the limited reliability of the scoring index used (i.e., the FAS index) [48]. A recent systematic analysis [45] showed that most studies (15 out of 20) have detected an association between socioeconomic status and adherence to the MD, although it should be pointed out that in most cases, parents' education level was used as a proxy variable.

In line with other similar studies [16,33,49], we observed that primary school children had a higher degree of adherence to the MD than secondary school students. This could be explained by adult supervision and control over children's diets, an influence that is progressively lost as an individual grows up. Some studies have shown that this parental control is associated with following healthy dietary habits and patterns [50–52].

The absence of distractions during mealtimes is also associated with a higher degree of adherence to a MD, although in our study a statistically significant difference was found only for breakfast. Recent studies have suggested that eating without distractions (such as television) has a positive association with a healthy lifestyle and reduces the risk of obesity [29,53]. It is possible that the absence of distractions may facilitate family supervision and the adoption of good dietary habits and may help avoid the negative effects of television advertising of food on dietary behavior in children and adolescents [46].

Regarding physical activity, our results were in line with the literature, showing a positive association between physical activity and other healthy lifestyle habits such as an adequate diet [20,25–28], as well as adherence to a MD [45]. However, we did not detect an increase in the degree of adherence to a MD with increased intensity of physical activity (vigorous vs light), as has been observed in other studies [44].

This study demonstrated that adherence to a MD was lower among adolescents and children who had money to spend at school. The availability of money is not a risk factor per se if there is no easily accessible unhealthy food. However, when this is available, children and adolescents can be influenced and may change their usual dietary habits. In fact, some studies have suggested that constant exposure to the offer of certain foods with a high calorie content or poor nutritional profile is positively associated with a deterioration in the nutritional state of children and young people [54–56]. As mentioned in the results, a reduction in MD adherence in adolescents was due in large part to an increase in the consumption of fast food, baked goods, and sweets. This offer of low-nutritional-value food is common in facilities and establishments that adolescents often use and can be found in the places where they carry out their daily activities: Fast food restaurants, cafes, convenience shops, places with vending machines, etc. [47]. The lower level of parental supervision due to adolescents' progressive independence, as well as the influence of their circle of friends and advertisements of certain foods, may facilitate negative changes at that point in the quality of their diet [46,47]. Likewise, higher prices in certain foods is another determinant that might explain this lower MD adherence in adolescents [57].

Finally, as in other studies on the factors associated with adherence to a MD [45], we did not find a statistically significant association with control variables such as age, sex, body mass index, or parents' country of origin. In our study, we observed a nonsignificant trend that children and adolescents getting fewer hours of sleep were less likely to have optimal adherence to the MD. This merits attention in future studies, as there is some existing evidence on the association between sleep duration and quality and diet [58], including the adherence to the MD in young adolescents [59]. In that sense, some studies have found an association between irregular eating, skipping breakfast, and lower intake of fruits and vegetables, all of them related to lower adherence to the MD. However, the relation between MD adherence and sleep duration remains unclear, and the mechanisms that explain such an association are likely to be multifactorial [60].

The design of this study did not allow us to establish causality for the significant associations studied. However, the concurrence with the results obtained in other studies highlights the interest in investigating the possible causality and mechanisms involved using appropriate designs.

Another limitation of the study, with regard to the population older than 12 years, was the use of questionnaires completed by the adolescents themselves. Although a teacher was present and available to help, this could represent information bias, as we could not confirm the reported information with the participants' parents. In addition, although the sampling design guaranteed the sample was representative of the city of Mataró, the results cannot be generalized to the Spanish population as a whole or to the rural population of Catalonia, because regional differences have been described in Spain as well as in rural versus urban populations [16]. Finally, this study lacked detailed information on factors related to socioeconomics, family history, and more objective evidence of the adherence to a MD, such as biochemical markers.

5. Conclusions

This study suggests that some factors (mother's education level, distractions at breakfast time, physical activity, and the availability of spending money) are associated with the likelihood of optimal adherence to the MD.

In view of these results, the design and implementation of any intervention to promote healthy habits and lifestyles (e.g., educational interventions) among children and adolescents of school age should consider the participation of parents, especially those with lower education levels. Likewise, another central component is targeting the period of adolescence, as there appears to be a decline in MD adherence in this segment of the population. Schools could be a convenient environment for such interventions.

Future research should study more in-depth the possible causality between the factors studied and adherence to the MD, as well as the mechanisms explaining it. What is also worthy of attention is research into the influence of the community environment to determine the effect of the offer of food on the habits of children and particularly adolescents.

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Articulo 2: Validity and Reliability of the Facility List Coder, a New Tool to Evaluate Community Food Environments

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Resumen

Objetivo: Validar el *Facility List Coder* (FLC) una nueva herramienta basada en información geo-localizada secundaria para la evaluación automática de entornos de alimentación a nivel comunitario.

Materiales y métodos: El FLC es un aplicativo que realiza un inventario de establecimientos con diferentes ofertas de alimentos alrededor de un sitio de interés (escuelas, parques, entre otros), a través de una consulta espacial de las principales bases de datos espaciales accesibles (Google Maps y Open Street Maps). Dicha información es analizada y clasificada a través de una lista de categorías preestablecidas que permiten tener medidas cuantitativas sobre la calidad y tipologías de los entornos de alimentación.

Para la validación se seleccionaron aleatoriamente un número representativo de segmentos de calles de 100 m^2 para la ciudad de Mataró (España), en los cuales se realizaron auditorías físicas con el fin de localizar e identificar los diferentes establecimientos presentes en cada una de las calles seleccionadas. Para cada uno de los establecimientos se recogió información sobre nombre, dirección y tipo de oferta a través de información alfa-numérica y registros fotográficos. A continuación, los resultados de las auditorias físicas fueron emparejados con el inventario identificado automáticamente por el FLC. La comparación entre los dos métodos se realizó a través de diferentes índices de concordancia con criterios continuos (t-test emparejado, gráfico de Bland-Altman, coeficiente de correlación intra-clase – ICC– y Krippendorff's alpha).

Resultados: No existe una diferencia sistemática entre la oferta de alimentos identificados automáticamente por el FLC y los auditados físicamente, con cerca del 78% de los segmentos de calles con el mismo número de establecimiento y el 93% con máximo un establecimiento de diferencia (t-test=0.97; p-value=0.329). Adicionalmente, se encontró un alto grado concordancia entre ambos métodos (ICC=0.9), incluso después de controlar por el posible sesgo de ceros (Krippendorff's alpha = 0.87; p-value=0.000). Este resultado se mantiene cuando se realiza por tipo de establecimiento.

Conclusiones: El FLC es una herramienta de bajo costo, escalable, eficiente, fácil de usar, fiable y válida para la evaluación de entornos de alimentación comunitarios de manera automática a través de uso de información secundaria geo-referenciada.

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Article

Validity and Reliability of the Facility List Coder, a New Tool to Evaluate Community Food Environments

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Abstract: A community food environment plays an essential role in explaining the healthy lifestyle patterns of its community members. However, there is a lack of compelling quantitative approaches to evaluate these environments. This study introduces and validates a new tool named the facility list coder (FLC), whose purpose is to assess food environments based on data sources and classification algorithms. Using the case of Mataró (Spain), we randomly selected 301 grids areas (100 m^2), in which we conducted street audits in order to physically identify all the facilities by name, address, and type. Then, audit-identified facilities were matched with those automatically-identified and were classified using the FLC to determine its quality. Our results suggest that automatically-identified and audit-identified food environments have a high level of agreement. The intra-class correlation coefficient (ICC) estimates and their respective 95% confidence intervals for the overall sample yield the result "excellent" (ICC ≥ 0.9) for the level of reliability of the FLC.

Keywords: community food environment; nutrition environment; geographical information systems (GIS); Facility List Coder; Python

1. Introduction

There is growing interest in understanding how the physical environment affects health outcomes, either directly or by creating a context in which people make health-related decisions [1]. Among the various different environs (e.g., sports facilities), community food environments have received increasing attention in the public health sector and from policy makers owing to their effects on diet and health outcomes such as obesity [2]. The transformation of the food and nutrition industry during the last decade, the increase of the availability of high calorie food (e.g., fast-food) (availability), the relative increase of healthy food prices over less healthy food options (affordability), and the increase of areas without a store where it is possible to buy fresh food (i.e., food desert) (accessibility), among other factors, evidence the fact that community food environments have changed dramatically during the last decades and play an important role in changing the food behaviors of adults as well as children [2–4].

Despite much qualitative evidence showing the influence of these new community food environments on food behaviors and health outcomes such as obesity, quantitative studies have found counter-intuitive or inconsistent results that suggest that the relationship between food environments and eating patterns is still far from being understood [2,4,5]. In a recent systematic review of the relationship between local food environments and obesity [3], they found limited evidence of the existence of this relationship despite the large number of studies included. However, the authors point out that the observed preeminence of null associations should be interpreted cautiously because of the

low quality of available studies. Likewise, [4] find very little evidence of an effect of community food environments surrounding schools on food purchases and consumption, but did find some evidence of an effect on body weight.

Many systematic review articles have been published attempting to explain this lack of quantitative evidence of the relationship between community food environments and health outcomes. These publications have suggested that the absence of compelling direct evidence is mainly the result of one factor: the insufficient validity and reliability of food environment measurements. [6,7] surveyed peer-reviewed publications from 1990 to 2015 in which food environments were assessed using quantitative approaches. They identified four types of methodologies used: (i) geographic analysis, (ii) sales analysis, (iii) nutrient analysis, and (iv) menu analysis. Only 25% of these studies show any metric evidence (i.e., validity and reliability indices) that validates their quantitative approach for food environments. These instruments are standardized assessment tools, such as the Nutrition Environment Measure Survey (NEMS) [8], which are typically paper-based forms filled out by the subjects themselves (i.e., self-reported) or by a trained observer. In general, these instruments present multiple methodological challenges that limit the understanding of a particular food environment: (i) limited geographical coverage, (ii) high sensitivity to the types of facilities included in the analysis, and (iii) high implementation costs, among others [6,7].

Other approaches that are receiving increasing attention for assessing food environments quantitatively are those methodologies based on geographical information system (GIS) technologies. These methods use the actual locations of the food facilities (i.e., stores, supermarkets) to estimate different measures such as facility density or proximity to the nearest facility [9]. On the basis of these measures, researchers are able to build different definitions of the level and intensity of exposure of a particular individual to a given food environment. Thereby, the GIS-based alternatives solve the problems of traditional methods, which creates a new and important opportunity to finally uncover the actual relationship between food environments and health outcomes, quantitatively [9].

Thanks to the considerable heterogeneity in the use of GIS methods and empirical evidence that utilize these techniques to analyze different food environments, their use has led to an increasing number of null results for the establishment of a robust association between community food environments and other health outcomes such as obesity and sedentarism, among others. In a recent systematic review, [9] conclude that the methodological constraints of using GIS methods center around the lack of validation evidence and standardization of data sources. Generally, information about facilities in community food environments is obtained using either administrative records or commercial sources with no extra quality validation. The resulting poor quality data can lead to uncertainty, bias, and reduced statistical power [10]. In order to boost the potential of GIS-based solutions for studying food environments, developing new validated, standardized, and replicable GIS-based methods are necessary to take advantage of this type of solution and, ultimately, to better understand food environments [9].

In our case, the need for a tool to assess urban environments arose when studying the prevalence of diet inadequacy in children and adolescents aged between 6 and 18 years from educational institutions in the city of Mataró (Catalonia, Spain) [11]. That study demonstrated that adherence to a Mediterranean diet was lower among adolescents and children who had money to spend at school. Because the availability of money is not a risk factor per se if there is no easily accessible unhealthy food, it was decided to study the food environment around schools. Thus, the aim of this paper is to introduce and assess the validity and reliability of a new GIS-based tool called the facility list coder (FLC), developed to meet the above-mentioned need. This tool is based on secondary data, and offers a low-cost, scalable, efficient, and user-friendly way to indirectly identify community nutritional environments.

2. Materials and Methods

2.1. Case Study Selection

In order to validate the FLC, we used the case of Mataró, a coastal city located near Barcelona (25 km) in Catalonia, Spain. The city has experienced an increase in population in the last 50 years (from 40,407 inhabitants in 1960 to 122,905 in 2010) owing to migration from other parts of Spain and, in recent years, from other nations (mainly from Morocco). The economy of Mataró is mainly based on services (63% of total invoicing) and industry (31%) [12]. The mixture of population and culture is associated with an increased risk of health-related problems such as child overweight and obesity [11]. Among the main determinants of this situation, the food environment around schools stands up. However, the lack of information on the number and type of facilities in this city has obstructed the analysis of the influence of food environment on nutritional outcome [11].

2.2. Secondary Data: Introducing the Facility List Coder (FLC)

The Facility List Coder (FLC) is an open source tool developed in Python 3.7 that combines GIS analysis with standard data techniques. In the present text, the term 'facility' is used to name any installation, equipment, or place that could be an element of interest when assessing community food environments. Besides other GIS-based solutions, the FLC collects geographical information and facility characteristics from two main GIS search-engines that are available online (Google Maps and Open Street Maps), performing a spatial query around a pre-defined zone around a centroid (e.g., homes or schools), after which information is classified based on the meta-data available for each location based on a comprehensive, multi-language list of key words that allows for the categorization of each facility. These data sets are built utilizing the concept of nodes (or places), which include any geographical objects, such as bridges, street lights, stores, schools, and parks, among others. Besides the geographical location, each place provides different types of information like their description, characteristics, and offers, among others. This information is a combination of self-reported data by users and centrally collected information by each company or organization.

The FLC performs a spatial query, retrieving all types of facilities present in a pre-defined zone (e.g., buffer around an interest point or any geographic object). In the case of Google Maps, we used the Application Programming Interface (API) that offers a low-cost and very efficient spatial query. For Open Street Maps, we implement a spatial query taking all nodes that could be classified as facilities. In order to avoid duplicates, FLC performs different techniques based on location, as well as all available meta-data for each location. Once the complete list of facilities is obtained, each facility (e.g., convenience food store, bar, and bakery) is automatically classified using the meta-data available in each data set. On the basis of the classification provided by [13], we built a comprehensive, multi-language list of key words that allows for the categorization of each facility into four types: (i) fast-food restaurants, (ii) bars/restaurants, (iii) supermarkets, and (iv) convenience stores and others. These categories can be modified to fulfill the specific needs of researchers; for example, related to geographical location, multi-lingual search options, or research questions. Although other researchers have used similar categories [13], our pre-defined multi-lingual key word list offers a contribution for researching community food environments within the European context, as empirical studies for Europe often use categories created for the United States, which might incorrectly estimate the particularities of European food traditions. Furthermore, this list can be easily modified and new terms can be incorporated or deleted depending on the needs of the researchers. Finally, taking advantage of the different measures available for GIS, the FLC provides different measures, such as (i) the geographical distance taking into account the road network, in kilometers; (ii) the average time of the walking distance, in minutes; and (iii) the average time of the cycling distance, in minutes. As its main output, the FLC offers a detailed data set for all the classified facilities located around each point of interest. Figure 1 resumes the FLC workflow. Original codes from FLC are available as Supplementary Material.

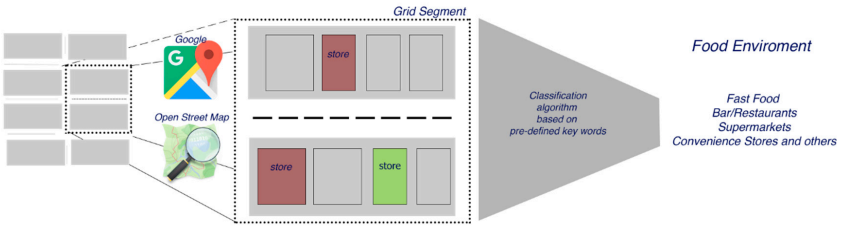

Figure 1. Facility list coder workflow (FLC). The diagram shows the steps performance for the FLC to assess the food environment. For a selected zone in the city map, a spatial query is performed using Google Maps and Open Street Maps, and data on different facilities located in the zone (e.g., food stores) are classified according pre-defined key words, so facilities can be classified in major categories to study the food environment.

2.3. Street Audits (Physical Verification)

In order to study the validity and reliability of the output provided by the FLC, we employed a physical verification test (street audits). For the purpose of creating an exogenous unit of analysis, we divided the territory under study into grids of 100 m by 100 m. In total, we created 1375 grids (see Figure 2).

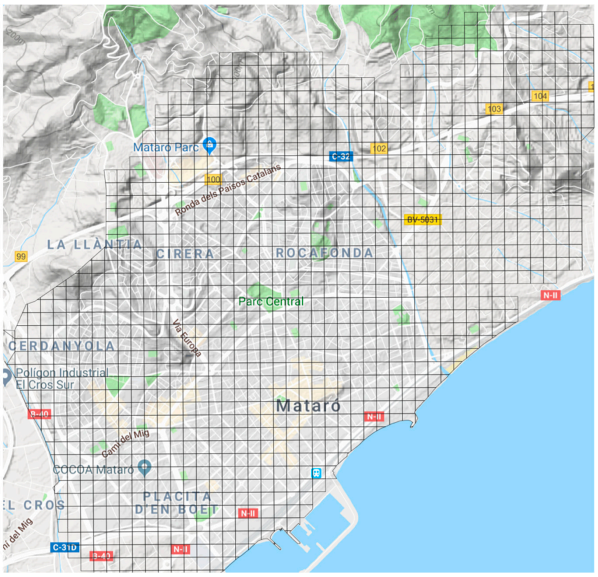

Figure 2. Sampling grids (100 m × 100 m) drawn over the Mataró map and used to sample audit grids.

On the basis of these grids ("buffer zone" in GIS terminology), we built a simple random sample using a 95% confidence level, with a finite population. In order to estimate the sample size, we used the FLC results to define the expected proportion and variance with a 95% confidence level. In total, 301 grids were randomly chosen (22% of the total). Figure 3 shows the final sample selection.

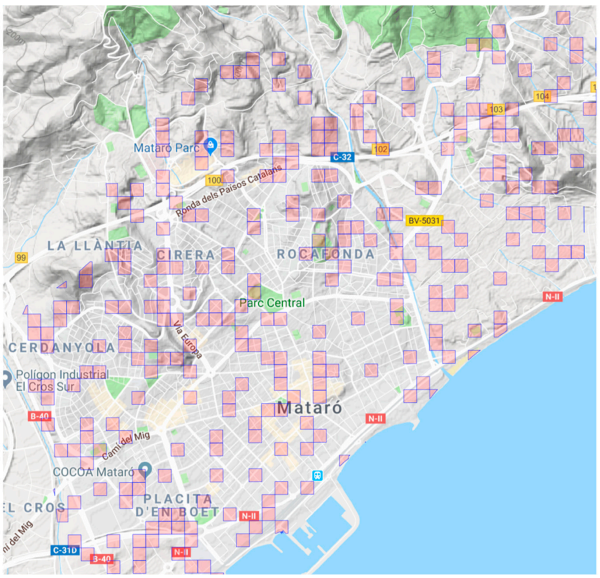

Figure 3. Randomly selected grids (100 m × 100 m) drawn over the Mataró map with the sampled street audits marked in magenta.

Two trained people walked the selected grid to record the facilities located along each grid using a tool developed previously with Open Data Kit (https://opendatakit.org/). For each of these facilities, they recorded its name, address, and exact coordinates, and took a picture of each storefront. Finally, on the basis of the classification provided by [13], our team classified each facility into four categories: (i) fast-food restaurants, (ii) bars/restaurants, (iii) supermarkets, and (iv) convenience stores and others. This physical verification was carried out in February of 2018.

The physical verification test allowed us to find three types of facilities: (i) facilities that were found using the FLC, but that were not physically present (false positives); (ii) facilities that exist, but were not identified by the FLC (false negatives); and (iii) those that were identified using both methods.

2.4. Statistical Analysis

A descriptive agreement analysis based on the paired t-test and Bland–Altman plot was performed to assess the differences in the number of facilities on each grid obtained using the FLC and those obtained in the street audit, which we consider the "gold standard" method. Whereas the paired t-test allowed us to determinate whether there exists a systematic difference between the two methods, the Bland–Altman plot allowed us to visually identify the agreement pattern by plotting the difference between the two methods on the vertical axis of the diagram with the average of these same methods on the horizontal axis [14]. So, both analyses provide information to study the validity of the FLC.

Then, in order to establish the degree of correlation between the two methods, we used the intra-class correlation coefficient (ICC), widely used for inter-rater reliability analysis. This index is based on McGraw and Wong [15] and there are 10 different forms of the ICC corresponding to different contexts. In our context, as we were interested in assessing the reliability based on the mean of the two methods (i.e., the FLC and field work); we estimated the ICC based on a mean-rating (k = 2), absolute-agreement, two-way mixed-effects model. ICC values less than 0.5 are indicative of poor reliability, values between 0.5 and 0.75 indicate moderate reliability, values between 0.75 and 0.9 indicate good reliability, and values greater than 0.90 indicate excellent reliability [16]. Moreover, to control for

the potential bias of having a lot of pairs of zeroes that may artificially inflate the apparent reliability, we used Krippendorff's alpha reliability estimate, which is an alternative to estimate reliability, allowing for controlling for the presence of zeros. All analyses were performed using R.

3. Results

After applying the facility list coder (FLC) to Mataró using 100 m × 100 m grids, we identified 935 facilities. According to our results, the most common type of facility was "bars/restaurants", representing 25.8% of all identified facilities, followed by "fast-food restaurants" with 18.9%.

Figure 4 shows an overview of the results from comparing the field work and the FLC results; purple color stands for false positives (i.e., FLC larger than field work), pink color stands for false negatives (i.e., FLC smaller than field work), and white color stands for a perfect match between the two methods. Overall, we found that the FLC performed well compared with the street audit. In fact, for 78% of the selected streets, we found the exact same number of facilities through both methods. Moreover, when allowing for a tolerance rate of just one facility (i.e., both methods could differ in +/– one facility), this agreement rate rose to 92.4%. Likewise, we found around 14% of false positives (those facilities that were found using the FLC, but that were not physically present) and 8% of false negatives (facilities that exist, but were not identified by the FLC). The paired t-test statistics is 0.976 with 573 degrees of freedom (p-value = 0.329). Hence, there was no evidence of a systematic difference between the results from the FLC and the field work. In both methods, we found that these methods are valid as they are able to properly represent the universe of facility in our case of study.

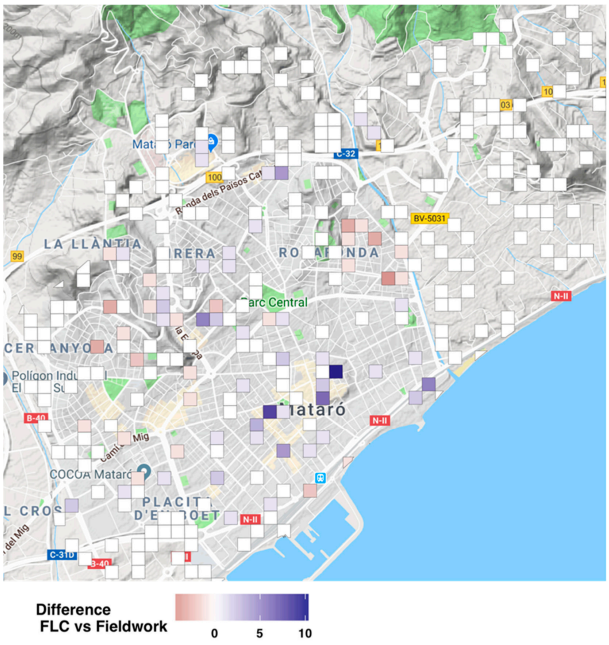

Figure 4. Spatial distribution of the difference between the FLC and the street audit (field work). The map shows the difference between facilities found using the FLC and street audit at the randomly selected grids; purple color stands for false positives (i.e., FLC larger than field work), pink color stands for false negatives (i.e., FLC smaller than field work), and white color stands for a perfect match between the two methods.

The Bland–Altman diagram provides a first glance at the pattern of agreement between the two methods (see Figure 5). As we pointed out, we observed a high level of agreement between the two methods for the total number of facilities per grid. However, we did find an important disagreement between the FLC and the field work results on those grids with the two largest numbers of facilities [9,10]. After checking manually, we found that these differences were mainly because of how local food markets were counted; whereas the field work treated the market as a single facility, the FLC coded all the facilities that were located within the markets individually, which is obviously more convenient.

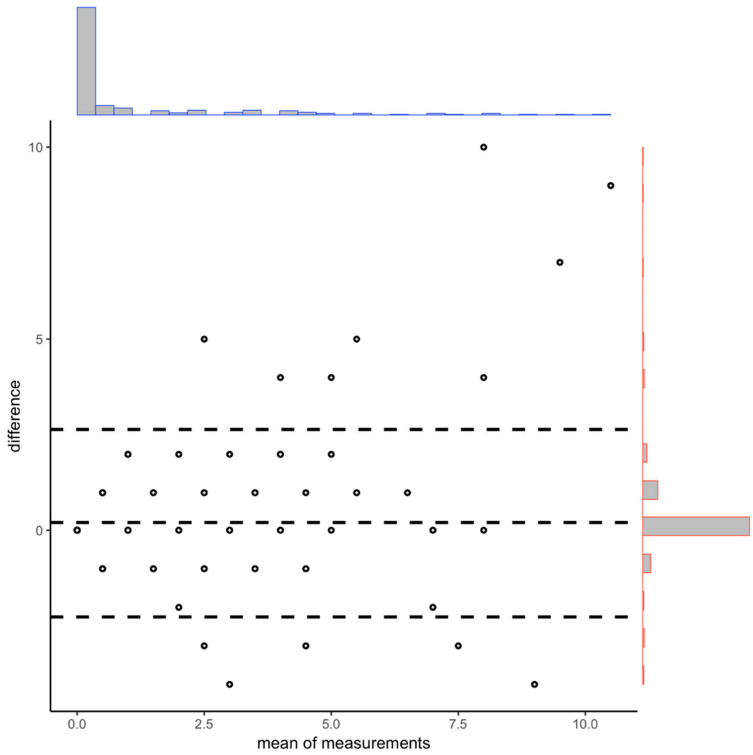

Figure 5. Bland and Altman diagram for the comparison of results obtained with FLC versus street audit.

The ICC estimates and their 95% confidence intervals for the overall sample indicated that the level of reliability is in the range of good to excellent. When we corrected the data for the local markets, our results got an excellent reliability index using the ICC, which were in any case always above 0.9. Once we take into account the zero bias (Krippendorff's alpha) results are still showing a high degree of reliability (see Table 1).

Table 1. Intra-class correlation coefficients (ICCs) calculated using a mean-rating (k = 2), absolute-agreement, two-way mixed-effects model. df, degrees of freedom.

	Interclass Correlation						Krippendorff's Alpha		False Positive Rate
	ICC index	95% Confidence Interval		F Test with True Value 0					
		Lower Bound	Upper Bound	Value	Degree of freedom 1	Degree of freedom 2	Significance		
Overerall Sample	0.898	0.872	0.919	9.94	300	287	0.000	0.875	14%
Overall sample after correcting for markets	0.933	0.916	0.946	14.9	297	296	0.000	0.870	13%

When we compared the ICC results by type of facility, we found good to excellent results for all types of facilities (Table 2). The ICC for bars/restaurants was excellent (0.92), followed by fast-food restaurants (0.86) and supermarkets (0.82). The worst performance was found within the category of convenience stores and others, where the ICC was 0.76, which is still acceptable according to the criteria mentioned above. These results suggest that the automatic classification of facilities performed by the FLC is consistent with the classification performed by direct observation. As before, Krippendorff's alpha confirms our results as well as the false positive rate.

Table 2. Intra-class correlation coefficients calculated using a mean-rating (k = 2), absolute-agreement, two-way mixed-effects model. Sample after correcting for markets.

	Interclass Correlation	95% Confidence Interval		F Test With True Value 0				Krippendorff's Alpha	False Positive Rate
		Lower Bound	Upper Bound	Value	Degree of freedom 1	Degree of freedom 2	Significance		
Fast Food	0.861	0.825	0.889	7.18	297	298	0.000	0.770	2%
Bar/Restaurants	0.926	0.907	0.941	13.5	296	297	0.000	0.840	11%
Supermarkets	0.827	0.780	0.864	5.96	297	237	0.000	0.810	5%
Convenience Stores and others	0.764	0.703	0.813	4.30	297	282	0.000	0.587	2%

4. Discussion

Assessing food environments using GIS-based approaches offers an ample methodological range of possibilities that can overcome the most traditional challenge to finding quantitative evidence for the relationship between food environments and health outcomes [3,4]. This study sought to validate a new tool called the facility list coder (FLC), which allows for evaluating community food environments, using secondary data obtained from the two most traditional geographical online search-engines: Google Maps and Open Street Maps. We used the case of Mataró (Spain) to validate this tool, comparing the automatic facility classification provided by the FLC with the 'gold-standard' obtained using physical direct verification. Our results indicate that the FLC has good to excellent reliability with respe

+ct to the street audit—hence, the FLC provides an excellent source of information for studying food environments.

The FLC fulfills the five main requirements suggested by [10] for validating a GIS-based approach to food environments: (i) food outlet data, (ii) extracting food outlets, (iii) defining food outlet constructs, (iv) geocoding methods, and (v) access metrics. Information for GIS search-engines is centrally managed by each company, yet they are often updated by users (food outlet data). As a result of this spatial query, we retrieved all types of facilities present in a pre-defined grids. Because a spatial query is based on a pre-defined location, including particular search terms (extracting food outlets) is

not necessary. Once the complete list of facilities is retrieved, they are classified using an exhaustive list of key words following [13]. Likewise, because other meta-data are also collected, information can be easily verified (defining food outlet constructs). Because the information is already geocoded, no further geocoding methods are needed (geocoding methods). Finally, taking advantage of the pre-defined GIS search-engine algorithms, the FLC provides different measurements of distances, such as network distance and walking distance, among others (access metrics).

One of the main concerns related to measuring food environments using secondary data sources is the lack of adequate evidence of their validity and reliability. Many researchers have highlighted this fact as being one of the main limitations of their studies [4,10,17]. Very often, researchers use a facility census or facility lists as the main source of information for assessing food environments. These data are mainly collected for official or commercial purposes and often present several limitations related to geographical location and update, which leads to high heterogeneity in the data quality among different sources. [18] compared two different data sources for food outlets in the United States and found that, depending on the data source selected, the level of statistical significance of the association between neighborhood racial and socioeconomic characteristics and food/alcohol facility density varies. This empirical problem is mainly the result of the large difference between the two data sources and it points out the importance of data validation in avoiding bias. In order to overcome these challenges, researchers should compare to a 'gold standard' like physical verification (street audits) [10,19]. Using this approach, [19] validated the two main data sources for the United Kingdom through street audit verification, concluding that these two secondary data sets provide a good view of the actual state of food environments. Nonetheless, utilizing a 'gold standard' is not always possible as it is often demanding financially as well as time-wise. In these cases, the FLC contributes good to excellent reliability and might offer a complementary data source for researchers so they can have a benchmark with which to validate or complement their initial results using the additional information for food environments.

Sociodemographic dimensions could trigger effects of any food environment on health outcomes [2]. Former studies have shown that low-income families are more likely to be affected by their surrounding food environment [4,20]. Hence, assessing validated and standardized measures of food environments can be difficult—for example, low-income areas pose an empirical challenge as administrative data are often low-quality or simply non-existent. In these cases, the FLC can be used as the main source of information to identify community food environments in cases where researchers or practitioners have a limited budget, or the area of study makes it impossible to utilize other intensive techniques such as a facility census. Furthermore, even considering that the quality of data provided by this GIS systems is not homogenous for all countries, this GIS information has worldwide coverage, so the FLC might provide a proxy for the food environment in places where the coverage and the data quality is good, but an official facility census or directory does not exist or is not available, as in our case. However, reproducibility of the FLC in other globe locations should be checked.

As [10] have mentioned, the GIS-based tool has limitations of which users need to be aware. As the FLC uses the most popular GIS search-engines to assess food environments, it can be a source of measurement error, as information could be either centrally generated by the search-engines or self-reported by users. Despite this, all the information available is verified and standardized to guarantee good quality control [21,22]. The fact that part of the information is self-reported by users might lead to the following potential limitations: (i) the FLC might underestimate the food environment in places with a small amount of GIS information and (ii) the FLC might misallocate facilities in locations where no further information is available. Although it is impossible to rule these biases out completely, other researchers [23] have evidenced the validity and good quality of this information. We confirm this in our research.

Another concern is the automatic facility classification into pre-defined categories. [13] present a literature review that delineates how to create a detailed guide for developing classifications of food environments. They conclude that it is not possible to provide only one classification that can be

applied in any context. Therefore, we opted for a simplistic and conservative classification adapted to the Spanish context for four categories: (i) fast-food restaurants, (ii) bars/restaurants, (iii) supermarkets, and (iv) convenience stores and others. As [19] claim, although this general classification does not take into account food provision within individual outlets nor other factors that may influence purchasing decisions, such as pricing and preferences, it provides an opportunity for a baseline analysis and it presents a possibility for future large-scale research projects [19].

The FLC is not the only tool that can be used to assess food environments using common online search-engines like Google Maps. The SPOTLIGHT-Virtual Audit Tool (S-VAT) uses the street views provided by Google Earth to develop a desk-based assessment of community food environments [21,24]. This tool was derived from a large European Union-funded project and was developed to identify and compare environmental characteristics in European neighborhoods. Along with the street images, researchers are provided with a pre-defined form through which they can virtually 'audit' each street segment by segment. As a result, on the basis of their storefronts, a list is compiled of all the facilities, as well as other characteristics such as walkability, cycling-related infrastructure, and public transport, among others. [21] found that S-VAT was a highly reliable tool for classifying food environments using street view images.

The FLC differs from the S-VAT in many ways. First, the FLC focuses only on determining the characteristics of each food environment through building a classification system of facilities in pre-defined categories, while the S-VAT only relies on the storefront image, which can lead to important misclassifications. Second, unlike the S-VAT, the results from the FLC provide a list of all the classified facilities, which allows for properly classifying every food environment. Third, as the S-VAT is based on the visual audit of each street, it is more difficult to collect meta-data or characteristics of each facility. The FLC gathers all the information available for each store (e.g., type, images, and opening hours), which provides a better understanding of the food environment. Therefore, the FLC and S-VAT, rather than being equivalent tools, complement one another.

5. Conclusions

To conclude, the FLC is a valid and reliable tool for evaluating community food environments in our case of study. This result is building evidence of the validity of using a GIS-based solution like FLC to evaluate food environments, which can be used either as a validation of other secondary data or as a main source of information. The FLC uses the most popular data sources (i.e., Google Maps and Open Street Maps) to identify the facilities present around a given location (e.g., school, hospital, and university). As a result, researchers can have access to a comprehensive list of facilities around any location of interest, allowing for a more detailed investigation that informs key research questions about the influence of food environments on multiple public health outcomes, such as obesity, sedentarism, and dietary patterns, among others. In sum, the FLC offers a new, low-cost, scalable, efficient, and user-friendly tool to assess food environments, and it can be implemented in different types of research projects that want to include food environments as a dimension of analysis.

Supplementary Materials: The original codes are available at https://github.com/jcmunozmora/facilitylistcoder.git.

Author Contributions: Conceptualization, A.M.A.-A. and A.F.-C.; Methodology, A.M.A.-A. and A.F.-C.; Software, A.M.A.-A. and J.C.M.-M.; Validation, A.M.A.-A. and J.C.M.-M.; Formal Analysis, A.M.A.-A., A.F.-C., and J.C.M.-M.; Investigation, A.M.A.-A. and A.F.-C.; Resources, A.M.A.-A. and A.F.-C.; Data Curation, A.M.A.-A. and J.C.M.-M.; Writing—Original Draft Preparation, A.M.A.-A., A.F.-C., and J.C.M.-M.; Writing—Review & Editing, A.F.-C.; Visualization, A.M.A.-A. and J.C.M.-M.; Supervision, A.F.-C.; Project Administration, A.M.A.-A.; Funding Acquisition, A.M.A.-A. and A.F.-C.

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Conflicts of Interest: The authors declare no conflict of interest.

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Artículo 3: Introducing the Facility List Coder: A New Dataset/Method to Evaluate Community Food Environments

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Resumen

Objetivo: Describir el procedimiento técnico del algoritmo y la base de datos resultante de la aplicación *Facility List Coder* (FLC) para la evaluación automática de entornos de alimentación a nivel comunitario, con el fin de facilitar su uso por otros investigadores en otros contextos.

Materiales y métodos: El FLC es un aplicativo desarrollado en Python 3.7 que realiza una clasificación automática del tipo de oferta alimentaria alrededor de un sitio de interés, a partir de consultas espaciales en las bases de datos más populares (Google maps y Open Street Map). El FLC fue presentado y validado en "*Validity and Reliability of the Facility List Coder, a New Tool to Evaluate Community Food Environments" at Int J Environ Res Public Health. 2019 Oct; 16(19): 3578*".

En el artículo se presenta paso a paso la implementación del FLC, los supuestos e insumos de información para su uso por otros investigadores. De este modo, se explica en detalle el proceso de clasificación y la posibilidad de su adaptación a otras preguntas de investigación o contextos culturales, a partir de incluir criterios adicionales para la identificación de los establecimientos o puntos de interés encontrados automáticamente por el FLC. Finalmente, se ofrece la estructura de la base de datos resultados del FLC, con el fin de brindar claridad sobre el tipo de análisis estadístico que se podría hacer posteriormente.

Resultados: Divulgación de códigos abiertos y diccionario de datos para replicar el FLC en otros lugares que tengan información disponible de Google Maps y/o Open Street Maps.

Conclusiones: El FLC puede ser usado por otros investigadores para obtener datos de variables útiles para evaluar entornos comunitarios de alimentación.

data

MDPI

Data Descriptor

Introducing the Facility List Coder: A New Dataset/Method to Evaluate Community Food Environments

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Abstract: Community food environments have been shown to be important determinants to explain dietary patterns. This data descriptor describes a typical dataset obtained after applying the Facility List Coder (FLC), a new tool to asses community food environments that was validated and presented. The FLC was developed in Python 3.7 combining GIS analysis with standard data techniques. It offers a low-cost, scalable, efficient, and user-friendly way to indirectly identify community nutritional environments in any context. The FLC uses the most open access information to identify the facilities (e.g., convenience food store, bar, bakery, etc.) present around a location of interest (e.g., school, hospital, or university). As a result, researchers will have a comprehensive list of facilities around any location of interest allowing the assessment of key research questions on the influence of the community food environment on different health outcomes (e.g., obesity, physical inactivity, or diet quality). The FLC can be used either as a main source of information or to complement traditional methods such as store census and official commercial lists, among others.

Dataset: https://github.com/jcmunozmora/facilitylistcoder.git

Keywords: community food environments; nutrition environment; geographical information technologies (GIS); facility list coder; Python

1. Summary

In spite of much qualitative evidence exhibiting the influence of community food environments on food behaviors and health outcomes such as obesity, many quantitative studies have found unexpected or inconsistent results that could indicate that the exposition to a specific food environment might exert influence on eating patterns [1–4]. Many scholars agree that one of the main explanations for the absence of compelling direct evidence is largely due to one factor: the insufficient validity and reliability of food environment measurements [5]. In fact, in a compilation of literature and a recent systematic review, McKinnon et al. [5] and Lytle et al. [6] showed that only 25% of those studies included in the analysis had any metric evidence that validated their quantitative approach for food environments. Therefore, their results were obtained from poor quality data sources leading to uncertainty, bias, and very low statistical power.

Among the different options to improve the quality and standardization of measuring food environments, the Geographical Information System (GIS) technologies-based solutions stand up.

These procedures use the actual positions of the food facilities (i.e., stores, supermarkets, etc.) to calculate different parameters such as facility density or proximity to the nearest facility [7]. Based on these measures, researchers are able to estimate the level and intensity of exposure of a particular subject to a given food environment. Thereby, GIS-based alternatives solve the difficulties of traditional methods, allowing new and important opportunities to finally discern quantitatively the probable relationship between food environments and health outcomes [7].

This data descriptor presents a typical dataset obtained after applying the Facility List Coder (FLC), a tool that was validated and presented in a previous paper [8]. The FLC is an open source Python code that combines GIS analysis with standard data analysis techniques. The FLC extracts geographical information and facility characteristics from two GIS search engines available online: Google Maps and Open Street Maps. These datasets are built using the concept of nodes (or places), which include any geographical objects, such as stores, restaurants, parks, gyms, bridges, and streetlights, among others. Besides the geographical location, each place provides additional information like their description, offers, and characteristics, among others.

2. Data Description

We present a typical dataset obtained after applying the FLC in a given geographical location. In particular, we provided information from Mataró (Spain), a city located near Barcelona (25 km) in Catalonia, Spain, which was used by Arcila et al. [8] as the case study to validate the FLC. Besides other GIS-based solutions [7,9], the FLC collects geographical information and facility characteristics from two main GIS search engines that are available online (Google Maps and Open Street Maps) conducting a spatial query around a predefined zone around a centroid (e.g., schools or homes), then information is classified into four international standardized categories [10]: (i) fast-food restaurants, (ii) bars/restaurants/bakery, (iii) supermarkets, and (iv) specialty stores and others (this dataset is available in the supplementary material). Thus, the final dataset will provide a full description of the food environment around the geographical region of analysis.

2.1. Format

As the main output, the FLC yields a comma-separated file (.csv).

2.2. Data Structure

Table 1 describes the structure of the output, where each row (unit of analysis) is at a facility located at the predefined buffer zone.

Table 1. Typical data structure from Facility List Coder output

Variable Name	Type	Description
category	Factor	Facility classification using the predefined classification
dist_cycling	Numeric/Float	Cycling distance from the facility to the interest point
dist_km	Numeric/Float	Road distance from the facility to the interest point
dist_walking	Numeric/Float	Walking time from the facility to the point
geo_id	String	ID from the spatial search engine (google/osm)
geo_web	String	Webpage available from the geo-engine
place_address	String	Facility address
place_lat	Numeric/Float	Facility location—latitude
place_lng	Numeric/Float	Facility location—longitude
place_name	String	Facility name
place_phone_number	String	Facility phone number
place_web	String	Facility webpage (if available)
li_id	Numeric/Float	Location of interest—ID
li_lat	Numeric/Float	Location of interest—latitude
li_lng	Numeric/Float	Location of interest—longitude
li_name	String	Location of interest—name

3. Methods

The FLC was developed in Python 3.7 combining GIS analysis with standard data techniques. Besides other GIS-based solutions [7,9], the FLC collects geographical information and facility characteristics from two main GIS search engines that are available online (Google Maps and Open Street Maps) performing a spatial query around a predefined zone around a centroid (e.g., school, hospital, or university), then information is classified based on the metadata available for each location based on a comprehensive, multilanguage list of key words that allows for the categorization of each facility. These datasets are built utilizing the concept of nodes (or places), which include any geographical objects, such as bridges, streetlights, stores, schools, and parks, among others.

The FLC performs a spatial query, retrieving all types of facilities present in a predefined zone (e.g., Euclidean buffer around an interest point or any customizable geographic polygons like street segments). In the case of Google Maps, we used the API that offers a low-cost and efficient spatial query. For Open Street Maps (OSM), we implemented a spatial query taking all nodes that could be classified as facilities. In order to avoid duplicates, the FLC performed different techniques based on location as well as all available metadata.

Once the complete list of facilities was obtained, each facility (e.g., bar, supermarket, convenience food store, bakery, etc.) was automatically filtered and classified using the metadata available in each dataset according to a predefined multilingual (Catalan, Spanish, and English) keyword set. This keyword set was first established using a comprehensive list of types of outlets developed by the Government of Catalonia (Spain) as the reference document [11]. Founded on international classification and specific European outlets, this document provides a classification of 10 different outlet types easily generalizable for any European context [10]. Based on these initial disaggregated subcategories, we built a more aggregated and internationally accepted classification [10], which classifies each facility into four types: (i) fast-food restaurants, (ii) bars/restaurants, (iii) supermarkets, and (iv) convenience stores and others. Table 2 presents the categories structure applied in the FLC. The four standardized categories provide an accurate classification of facilities in any context compared with the audited data [8]. In contrast, as the automatic classification for subcategories needs more information from each facility, its accuracy might vary among different contexts [8]. Currently, we are working in a new version of the FLC using matching learning techniques to increase the accuracy of the classification for subcategory level in any context.

Table 2. Classification categories and subcategories.

International Category	Subcategory	Other Information
Bars/Restaurants/Bakery	Bakery	Pastry shop
	Bar, Restaurant	Kiosk
Fast-Food Restaurants	Fast-Food Restaurant	Churreria, frankfurt
	Ice Cream Store	Orcheteria
Supermarkets	Supermarket	Local market, grocery store, frozen store, mini markets
Specialty Stores and Others	Fish Shop	
	Fruit, Vegetable Store	
	Eggs Store	
	Dairy Products	Cheese shop
	Oil Shop	
	Butchery	Butcher shop

Buffer-related parameters and facility categories can be modified to satisfy the specific needs of researchers related to geographical location, multilingual search options, or research questions. Even though other researchers have used similar categories [10], the use of our predefined multilingual key word list offers a contribution for researching community food environments outside the US context, as

it allows standardizing the local food traditions into an international classification. For instance, in the European context, a specialized nuts store would not have had any classification following the US standards, yet the FLC offers the possibility to adapt these particularities into a traditional classification. That is, the key word list is easily modified and new terms incorporated or deleted depending on the needs of the researchers or the context. Finally, taking advantage of the different measures available for GIS, the FLC provides: (i) the geographical distance taking into account the road network and traffic based on Google API, in kilometers, (ii) the average time of the walking distance, in minutes, and (iii) the average time of the cycling distance taking into account traffic, in minutes. As its main output, the FLC offers a detailed dataset for all the classified facilities located around each point of interest.

Instructions to Use the FLC in Any Specific Context

The main use of the FLC is the evaluation of the community food environment around a specific interest point (e.g., school or university, among others). Thus, users must provide the geo-location of the point or location of interest (LI), and the size of the zone or buffer around the LI in which the food environment will be evaluated. In the literature, the threshold is often defined as around 1 to 1.6 km [12]. For instance, in a performed study of schooling food environment made by the authors (not published), the FLC listed the facilities present around 1 km from each school. Based on this information, the FLC retrieves the full list of facilities located within the defined zone around the LI. Using the predefined key words list, the FLC will generate a dataset where facilities are classified into four types: (i) fast-food restaurants, (ii) bars/restaurants, (iii) supermarkets, and (iv) convenience stores and others. Despite these predefined keywords meant to be as comprehensive as possible within the European context, these categories could be modified in order to fulfill specific needs of researchers related to geographical location, languages, or research questions.

Once a specific place is identified within a keyword for a pre-established category, the FLC estimates different indicators of relative distance to the LI. In particular, the FLC provides information on: (i) geographic distance (in kilometers) considering the road network using both Google API and OSM; (ii) the average time walking distance (in minutes), taking into account traffic density using Google API; and (iii) the average time cycling distance (in minutes), based on the traffic as well as road structure. As a main output, the FLC offers a detailed dataset for all the classified facilities located around each interest point. Figure 1 illustrates the process.

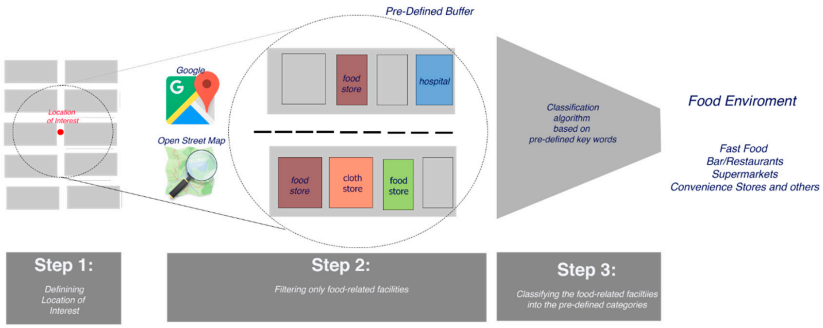

Figure 1. Facility List Coder workflow. The diagram shows the three-step process for the FLC to assess the food environment around a location of interest. For a selected zone in the city map, a spatial query is performed using Google Maps and Open Street Maps, and data on different facilities located in the zone (e.g., food stores) are filtered and classified according to predefined key words, so facilities can be classified into major categories to study the food environment.

4. Final Remarks

The FLC can be used either as a main source of information or to complement traditional methods such as store census and official commercial lists, among others. It uses the most popular GIS search engines to assess the food environment, so this can be a source of potential errors because information could be either centrally generated by search engines or self-reported by facility owners/representatives. Despite the fact that all information is verified and standardized by the search engines, having self-reported information might lead to the following caveats: (i) the FLC will underestimate the food environment in places with low GIS information; (ii) the FLC will misallocate facilities in locations where no further information about the places is available. It is a very unlikely scenario as both sources of information have a very standardized method to collect this information.

Supplementary Materials: The original codes, keywords of datasets, and the FLC for Mataró are available at https://github.com/jcmunozmora/facilitylistcoder.git.

Author Contributions: A.M.A.-A, A.F.-C., and J.C.M.-M. performed the statistical analysis and elaborated the syntaxes. A.M.A.-A. and A.F.-C. performed the interpretation of results and wrote the first draft. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest: The authors declare no conflict of interest.

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Artículo 4: Cross-Cultural Adaptation, Validity and Feasibility of the Spanish Version of School Physical Activity and Nutrition Environment Tool – SPAN-ET-

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Resumen

Objetivo: Adaptar y validar a la cultura española la herramienta para evaluar el microentrono escolar llamada *School Physical Activity and Nutrition Environment Tool* (SPAN-ET).

Materiales y métodos: A partir de las directrices metodológicas para la adaptación transcultural de instrumentos de recolección de información, el proceso consistió en cinco etapas: **(i)** en un primer momento, el instrumento es traducido del idioma inglés al español por dos profesionales de manera independiente (*traducción hacia adelante)*; **(ii)** los instrumento en Español son consolidados y corregidos por un grupo de expertos *(síntesis)*; **(iii)** el documento resultado es traducido de vuelta al Inglés con el fin de constatar con los creadores si el documento corregido conserva las dimensiones del documento original (*traducción hacia atrás o retrotraducción)*; **(iv)** los comentarios de los creadores son incorporados para generar una primera versión del instrumento, el cual incluye las equivalencias culturales y legislativas para contexto Español *(comité de expertos);* **(iv)** finalmente, el instrumento fue probado en cinco escuelas de la ciudad de Santa Coloma de Gramanet a fin comprobar su viabilidad y factibilidad para escuelas Españolas *(prueba piloto).*

Con el fin de complementar este proceso, se realizó un análisis de validez del contenido a través de un grupo de expertos para evaluar el nivel de comprensibilidad, aplicabilidad y adecuación cultural de SPAN-ET para su uso en España. La prueba piloto se realizó en cinco escuelas de la ciudad de Santa Coloma de Gramanet, España.

Resultados: El resultado de las diferentes etapas metodológicas de traducción y adaptación cultural del SPAN-ET para el contexto español permitió tener un nuevo instrumento para la evaluación de entornos escolares en España llamada SPAN-ET-ES. La evaluación realizada por el comité de expertos concluyó que los elementos incluidos en la versión SPAN-ET-ES eran relevantes para el contexto español (S-CVI/Ave=0,96), claros (S-CVI/Ave=0,96), sencillos (S-CVI/Ave=0,98) y sin ambigüedades (S-CVI/Ave=0,98). Finalmente, la prueba piloto ofreció evidencia empírica sobre la viabilidad y factibilidad del SPAN-ET para evaluar el micro-entorno escolar en España.

Conclusiones: Tras aplicar las directrices para la traducción y adaptación cultural de SPAN-ET al contexto español, se dispone de la nueva herramienta para la evaluación de entornos escolares en España llamada SPAN-ET-ES.

La factibilidad de la herramienta está determinada y aunque el estudio piloto muestra una tendencia hacia una herramienta fiable, esta última característica aún está por constatar en una la siguiente fase del estudio.

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Original Research Article

Cross-Cultural Adaptation, Content Validity and Feasibility of the Spanish Version of School Physical Activity and Nutrition Environment Tool – SPAN-ET

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Abstract

Background: Interventions based on improving nutritional and physical activity environments within schools have been considered as an important factor to establish lifelong healthy habits in school-age population. In this setting, it is important to measure with standardized tools that allow to deeply understand the complexity of the school behavioral environments. The School Physical Activity and Nutrition Environment Tool (SPAN-ET) is a valuable tool to make a comprehensive assessment of the school micro-environment in three environmental categories: policy, situation/social, physical that underscore students' nutrition and physical activity behaviors at school. In this study, we performed a cross-cultural adaptation and partially validated the SPAN-ET for the Spanish context.

Methods: We followed the cross-cultural adaptation guidelines which consists of a five-stage methodological approach: (i) forward translation; (ii) synthesis; (iii) back translation; (iv) expert committee review; and, (v) pilot testing. In addition, we applied as a content validity analysis through an expert committee to assess the level of comprehensibility, applicability, and cultural appropriateness of SPAN-ET for its use in Spain. Additionally, a pilot test in five schools was performed to assess the feasibility of the tool in the Spanish context.

Results: After applying the guidelines for the translation and cultural adaptation of the SPAN-ET into a Spanish context, the new tool (SPAN-ET-ES) is available to evaluate the school environment in Spain. The evaluation of SPAN-ET-ES made by the expert committee concluded that items included in the revised version of the SPAN-ET-ES were relevant for the Spanish context (S-CVI/Ave=0.96), clear (S-CVI/Ave=0.96), simply (S-CVI/Ave=0.98), and with non-ambiguity (S-CVI/Ave=0.98). Finally, the pilot test offered empirical evidence about the feasibility of the SPAN-ET at assessing the school micro-environment in Spain.

Conclusion: SPAN-ET-ES is a feasible tool to assess nutrition and physical activity environments in Spanish context.

Keywords: cross cultural adaptation, SPAN-ET, microenvironment, school environment, evaluation, behavioral context

Introduction

Environmental and policy interventions based on boosting micro-environments that emphasize healthy behaviors within school age populations have been identified as the most promising strategies for creating population-wide improvements in dietary and physical activity patterns, and weight status(1). These strategies often take place within the school, where children spend considerable daylight time and consume between one-third to one-half of their meals, making this micro-environment a critical influence for forming and reinforcing healthy lifestyle habits (2). Thereby, it is very important to understand the conditions and consequences of the school micro-environmental exposures that might underscore students' lifelong dietary and activity habits which influence future risk of obesity and cardiometabolic diseases (3,4).

Multiples scholars have documented the effectiveness of school based interventions aimed at nutrition and physical activity environments(5), yet there is still a dearth of understanding on the actual mechanisms through which those intervention might modify, or not, behavioral patterns at the student level. This gap of knowledge is even larger when analyzing the potential subsequent effect of environmental interventions on the institutions and policies of such interventions(5). In this context, the School Physical Activity and Nutrition Environment Tool (SPAN-ET) holds value in the United States (U.S.) for comprehensively assessing the school micro-environment in its role for nutrition and physical activities along three environmental categories: physical, situational, and policy(6). Using several methods of collecting data (e.g. face-to-face and/or telephone interviews, on-site direct observations, and document content review) and triangulating confirmed data criteria, SPAN-ET surveys and scores school resources and readiness to improve nutrition and physical activity environments. SPAN-ET assesments are used by each school to set priorities and select strategies to

improve the context through environmentally-based treatments. SPAN-ET was created and validated for the U.S. elementary school context and in English by Oregon State University researchers(6). Despite that its method and content are relevant, a simple language translation does not allow to use it in another countries, as law regulations and cultural context might vary among them.

This paper aims at proving a cross-cultural adaptation and validation of the SPAN-ET for its use in Spain. By following the guidelines of the International Society for Pharmacoeconomics and Outcomes Research (ISPOR) for the translation and cultural adaptation, performing a content validation and applying a pilot testing, we want to provide a full new version of SPAN-ET in Spanish (SPAN-ET-ES, hereafter) ready to be used for assessing school micro-environment in Spain.

Methods

Baseline instrument: School Physical Activity and Nutrition Environment Tool (SPAN-ET)

The SPAN-ET is an standardized instrument that provides a comprehensive observational assessment of the school features, practices, and policies within the school environment that might affect physical activity and healthy nutrition habits in elementary schools among children(6). As a result, SPAN-ET identifies the critical areas within the school with measured needs for improving the environments that promote healthy nutrition and/or physical activity habits, enhance student learning outcomes and supports core competences of partnerships and learning strategies(6).

In schools, the physical and policy environments determine the behavioral context, the school's situational environment which in turn affects physical activity and nutrition in children in school(6). In brief, SPAN-ET evaluates the school physical activity and nutrition contexts through 27 items, referred to as 'Areas of Interest' (AI, hereafter),

which are organized within three environmental categories: physical, situational, and policy. Figure 1 visualizes the multidimensional and interactive framework of the SPAN-ET model for quantifying the quality of the school physical activity and nutrition contexts across the three environmental categories (6).

In order to evaluate each AI, SPAN-ET provides a set of criteria that describes evidence-based best practice in each AI. For instance, for the AI of neighborhood features the set of criteria to characterize a best practice include:

- Safe roadways with sidewalks, bicycle lanes, and clearly marked crosswalks
- Traffic calming features such as speed signs, road humps, chicanes, and curb extensions
- Signals that supports safe, active transport to and from school
- Bicycle storage racks
- Pathways to playgrounds and athletic facilities that avoid vehicular traffic

If a school under evaluation fulfils at least 75 per cent of the set criteria, we can conclude that this institution has the best practice in this given AI. If, in contrast, it only fulfils less than 25 per cent of the criteria, we conclude that this institution has poor practice. The same rationale could be applied at the aggregated level using the environmental categories. Table 1 shows the entire set of evaluation for each AI or environment.

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Table 1. Assessment based on the criteria review. In each area of interest, several items are assessed in the school and, according to the percentage of fulfillment accomplished, the school practice grade in this area is determined.

Poor Practice	Fair Practice	Good Practice	Best Practice
≤ 25% No/very few criteria are met, can be seen or documented.	26% ≤ 50% Some criteria are met, can be seen or documented.	51% ≤ 75% Many criteria are met, can be seen or documented.	76% ≤ 100% Most criteria are met; some may exceed current best practice.

The set of criteria for each AI might cover different type facets that requires different type of information. Thereby, the use of the SPAN-ET implies triangulation of different qualitative and quantitative information using techniques such as: direct observation, photography, interview, document review, among others. During the school visit, two auditors observe physical and situational environments and interview all informants necessary to adequately assess each AI. Table 2 identifies the key informant category as well as specific examples of who fits within the category.

Table 2. List of potential informants that could be interviewed during a school evaluation.

Informant Category	Informants
School Administrator	Principal; Assistant Principal
Teacher	Grade/Classroom; Physical Education; Health
District Food Service Director	District-level director of food services (or equivalent)
Cafeteria Staff	School meal program manager; cafeteria staff
Classified/Volunteer Staff, specifically:]	Teacher aides; instructional assistants; Extension educator; garden coordinator; before/after school program coordinator
Wellness	Wellness committee chairperson or members; school nurse; counselor
Other, specifically:	Parents; school bus driver; maintenance

Once school administrators agree to participate in and accommodate to the SPAN-ET activities, schools are asked to provide two main sources of information: (i) institutional documentation about nutrition, physical activities or any relevant document containing

the institutional guidelines (*secondary data*); and, (ii) interviews to key informants listed in Table 2 (*primary data*). The two auditors independently code each item. Before interviews and physical visits, the auditors reviewed in detail all the documentation making an initial assessment of each AI. Then, they schedule a school visit during which they conduct interviews with key informants from which auditors could validate or change their initial assessment. These data sources are complemented with systematic direct observations of physical and situational environments that are conducted before, during, and after the school day. According to the original developers, in the US context trained auditors familiar with the instrument and practiced in qualitative data collection methods completed the data collection and coding process in 10-12h (per auditor), with about half the total time, on average, spent at the school site conducting interviews and direct observations.

After the completion of data collection, auditors review item by item to identify the level of agreement. When a disagreement occurs, auditors re-review all the available evidence as well as their perceptions in order to get an agreement. Thus, the final scoring of a given AI assessment is the result of the consensus between the two auditors. Finally, once the 27 AI are evaluated, a comprehensive report is delivered to each school in order to provide feedback on possible solutions to those AI where poor or fair practice were identified. In those AIs where good practice were found, a set of recommendations are suggested based on the public policy available or best practice activities identified in similar contexts.

Cross-cultural adaptation, content validation and feasibility

Using instruments that were written and validated in another languages brings important challenges when applying in different cultural context. The traditional

assumption is that the translation itself ensure retention of psychometric properties such as validity and reliability at an item and/or a scale level (7). However, when trying to gather information using an instrument that was literally translated from a foreigner language, it may happen that a specific term has a different meaning in this new culture that makes data collection fails. Thus, rather than offering a "word by word" translation, it is necessary to follow a systematic approach to guarantee a "world by world" translation (7).

This cross-cultural adaptation was conducted from September 2018 to August 2019. According to the "Guideline for process of cross-cultural adaptation" proposed by Beaton et al. (7), we follow a five-stage methodological process that contains the standard stages suggested by Beaton et al. as well as a content validity analysis to obtain a better adapted version for the Spanish context . Figure 1 describes each stage. As a result, we provide a new version of the SPAN-ET for its use in Spain, that we called SPAN-ET-ES. The translation and cross- cultural adaptation were conducted using the English version of the SPAN-ET provided directly from the original developers.

Stages I and II: Forward translation (FT) and Synthesis

The first step for the cross-cultural validation was the initial translation from English into Spanish (forward translation). In order to identify translation discrepancies as well as lack of equivalent wording in specific questions and other theoretical or cultural differences, two independent translators with proficient English and different background were selected (7). The first translator, in charge of the forward translation 1 (FT-1), was an experienced nutritionist in obesogenic environment and other related topics who translated the SPAN-ET putting special attention on the concepts and theory. The second one (FT-2) was an English teacher with no background in nutrition

or any medical science who translated the document giving more emphasis on plain language.

Once the FT-1 and the FT-2 were provided, an expert committee compared them in order to identify the main agreements and disagreements. This committee consisted of three researches with experiences on developing questionnaires for the Spanish context. In most cases, both FT-1 and FT-2 agreed in wording and phrasing of the translation. The committee contacted the SPAN-ET developers to clarify a few cases where there was disagreement in the Spanish translation. After this feedback and discussion, the synthesis version of the SPAN-ET-ES was launched.

Stage III: Back translation (BT)

Two independent professional English translators with no knowledge of the original SPAN-ET were asked to translate back the SPAN-ET-ES from Spanish to English. These two new versions of the SPAN-ET were again reviewed and refined by the expert committee. The reviewed version was sent to the original developers to analyze the accuracy and proximity of these new version with respect to the original. Based on the final feedback and discussion, a second version of the SPAN-ET-ES was ready. In all the translation stages, it was intended to maintain the semantic, idiomatic, experiential and conceptual equivalence between the source text in English and its Spanish version (7).

Stage IV: Expert Committee Review

Based on the new version, the expert committee performed a comprehensive context adaptation in two main topics. On one hand, as the original instrument were based on the US legislation, the committee included the equivalent reference using the Spanish regulation counterpart. On the other hand, the committee incorporated the Spanish equivalences of all references related to the US education system (e.g. calendar, dining

room, metric system, among others). All these adaptations required and extensive revision of Spanish legislation, regulations and guides on different issues (school canteens, playgrounds and sport installations, school accessibility, children food guides, etc.) and, in some few cases, its comparation with US equivalences.

2.2.4. Content Validity Analysis

After the context validation, SPAN-ET-ES was tested to assess the level of comprehensibility, applicability, and cultural appropriateness in the Spanish context. To do this, we performed a content validity analysis (8) where a panel of five experts with different background in nutrition, medical science, nursing and public health were invited to evaluate each AI of the SPAN-ET-ES (9,10). Using a four-point scale, each expert was asked to evaluate four dimensions of each AI: relevance, clarity, simplicity and ambiguity (see Table 3). Additionally, each expert had the possibility to include observations and comments for each AI.

Table 3. Criteria for measuring content validity(8)

Four-point scale for the ICV			
1	2	3	4
Relevance			
Not relevant	Item need some revision	Relevant but need minor revision	Very relevant
Clarity			
Not clear	Item need some revision	Clear but need minor revision	Very clear
Simplicity			
Not simple	Item need some revision	Simple but need minor revision	Very simple
Ambiguity			
Doubtful	Item need some revision	No doubt but need minor revision	Meaning is clear

Based on the experts assessment, we compute the content validity of individual item (I-CVI), which is the share of experts giving a rating of either 3 or 4 in each dimension(10):

$$\text{I-CVI}=\frac{\sum_{i=1}^{N}\text{CVI}_i}{N}$$

Once the I-CVI was calculated by each AI, we estimated an aggregated approach of content validity by environment and by the entire instrument(11). For doing this, we estimate the content validity of the overall scale average (S-CVI/Ave):

$$\text{S-CVI/Ave}=\frac{\sum_{j=1}^{I}\text{I-CVI}_i}{I}$$

In sum, whereas I-CVI provides a comprehensive assessment on the relevance, clarity, simplicity and ambiguity of each AI, the S-CVI/Ave provide a general overview of these dimensions at the environment level. We developed an online tool using Open Data Kit 8 (opendatakit.org) in order to facilitate the review by the experts. Once collected, information was analyzed using Stata 14 (StataCorp LLC, Texas, USA).

Stage V: Pilot Testing

Once the new version of the SPAN-ET-ES was obtained from the content validity analysis, we performed a pilot test. This was carried out in the city of Santa Coloma de Gramenet, a city next to Barcelona, in Catalonia (Spain). According to the latest national registry in 2019 (12), Santa Coloma was estimated to have 119,215 inhabitants and have a per capita gross income of 22.539 €. Based on the number of inhabitants, Santa Coloma could be considered an average Mediterranean city. In total we visited five public schools. Two well trained researchers performed the evaluation, following the guidelines provided for the original developers (6).

Results

SPAN-ET translation and cross-cultural adaptation

After the forward and back translation took place, a revised version was discussed with the original developers who agreed on the new wording and re-rephrasing. Once the research team had the certainty that the SPAN-ET-ES kept the main dimensions of the original instrument, the context adaptation was performed in order to make the SPAN-ET-ES compatible with the legislation and other particularities of the Spanish context. In this process we added three items and deleted one. First, in order to gather information about the participation in various programs to promote physical activity within the school launched by the public agencies, municipalities or non-profit organizations (13–15) we included a new item in AI 12 (Table 4). Additionally, we added two items in AI 16 and AI 27, in which we ask information referring to the existence of strategies to teach healthy habits about the use of new technologies and its potential effect on the physical activity (AI 16) and nutrition (AI 27) among children. Second, as the item about the presence of health nutrition educator did not apply for the Spanish context (this figure doesn't exist in Spain), we deleted item H in AI 27.

Furthermore, the new version undergone small changes in format, phrasing and content, in order to simplify its application in the Spain. In total, we made 38 changes through the instrument. No changes were made in the answer scale. After applying the initial methodological stages (I to IV), we concluded that the SPAN-ET-ES could be considered a Spanish version equivalent to the original tool. A detailed report on the changes are available upon request. Table 4 resumes the main changes performed according to the original version.

Table 4. Number of items and changes performed on them during the translation and cross-cultural validation process for the SPAN-ET-ES.

Content	*SPAN-ET (# items)*	*SPAN-ET-ES (# items)*	*# changes made*	*Main modifications*

Physical activity	**106**	**108**		
Physical environment	*50*	*50*		
AI 1: Indoor Physical Activity Space	15	15	8	Legislation and phrasing
AI 2: Fixed-Outdoor Features/Space	9	9	3	
AI 3: Shelter and Shade Structures	3	3		
AI 4: Natural Features	4	4		
AI 5: Garden Features	3	3		
AI 6: Surface and Surface Markings	4	4	1	Cultural context
AI 7: Enclosures and Safety Features	7	7	4	Legislation
AI 8: Neighborhood Features	5	5	1	Phrasing
TOTAL			**17**	
Situational environment	*32*	*33*		
AI 9: Portable Equipment	5	5		
AI 10: Atmosphere/Ambiance	7	7		
AI 11: Promoting Movement Opportunities	6	6		
AI12: Before/After School and Summer Extracurricular	11	12	1	Item added
AI 13: Gardening	3	3		
TOTAL			**1**	
Policy environment	*24*	*25*		
AI 14: Physical Activity and Wellness Policy	10	10	1	Legislation and cultural context
AI 15: Physical Activity and Wellness Committee	5	5		
AI 16: Structured Physical Education	9	10	2	Cultural context; item added
TOTAL			**3**	
TOTAL FOR PHYSICAL ACTIVITY			***21***	
Nutrition	**81**	**81**		
Physical environment	*7*	*7*		
AI 17: Cafeteria/Meal Service Area	5	5		
AI 18: Garden Features	2	2		
TOTAL			**0**	
Situational environment	*46*	*46*		
AI 19: School Meals	9	9	2	Legislation and cultural context
AI 20: Promoting Healthy Food and Beverage Habits	7	7	1	Legislation
AI 21: Healthy Food and Beverage Practices	5	5	2	Legislation and cultural context
AI 22: Promoting Water Consumption	8	8	1	Phrasing
AI 23: Cafeteria Atmosphere/Ambiance	10	10	1	Cultural context
AI24: Before/After School and Summer Extracurricular	7	7	1	Legislation and phrasing
TOTAL			**8**	
Policy environment	*28*	*28*		
AI 25: Nutrition and Wellness Policy	15	15	5	Legislation, cultural context and phrasing
AI 26: Nutrition and Wellness Committee	5	5		
AI 27: Health and Nutrition Education	8	8	4	Legislation and cultural context; one item added and one suppressed
TOTAL			**9**	
TOTAL FOR NUTRITION			***17***	

Content Validity Analysis

After the translation and cross-cultural adaptation process and the discussion and feedback from the original developers, a content validity analysis was performed. In overall, the expert panel considered that, on average, items included in the revised version of the SPAN-ET-ES were found relevant (S-CVI/Ave=0.96), clear (S-

CVI/Ave=0.96), simply (S-CVI/Ave=0.98), and with non-ambiguity (S-CVI/Ave=0.98). When looking at the environment level, we found that whereas AI contained within the Physical Activity environment were considered very relevant, we had to implement minor changes for four AI (relevancy - ICV < 0.8) within the Nutrition environment as experts considered that they were not applicable for the Spanish context. Table 5 resumes the content analysis results for the SPAN-ET-ES.

Table 5. Overall Scale Average (S-CVI/Ave) for each area of interest in the SPAN-ET-ES

Items	***Relevance I-CVI***	***Clarity I-CVI***	***Simplicity I-CVI***	***Ambiguity I-CVI***
Physical activity	**1.0**	**1.0**	**1.0**	**1.0**
Physical environment	1.0	1.0	1.0	1.0
AI 1: Indoor Physical Activity Space	1.0	1.0	1.0	1.0
AI 2: Fixed-Outdoor Features/Space	1.0	1.0	1.0	1.0
AI 3: Shelter and Shade Structures	1.0	1.0	1.0	1.0
AI 4: Natural Features	1.0	1.0	1.0	1.0
AI 5: Garden Features	1.0	1.0	1.0	0.8
AI 6: Surface and Surface Markings	1.0	1.0	1.0	1.0
AI 7: Enclosures and Safety Features	1.0	1.0	1.0	1.0
AI 8: Neighborhood Features	1.0	1.0	1.0	1.0
Situational environment	*1.0*	*1.0*	*1.0*	*1.0*
AI 9: Portable Equipment	1.0	1.0	1.0	1.0
AI 10: Atmosphere/Ambiance	1.0	1.0	1.0	1.0
AI 11: Promoting Movement Opportunities	1.0	1.0	1.0	1.0
AI 12: Before/After School and Summer Extracurricular	1.0	1.0	1.0	1.0
AI 13: Gardening	1.0	1.0	1.0	1.0
Policy environment	*0.9*	*0.9*	*1.0*	*0.9*
AI 14: Physical Activity and Wellness Policy	1.0	0.8	1.0	1.0
AI 15: Physical Activity and Wellness Committee	0.8	1.0	1.0	0.8
AI 16: Structured Physical Education	1.0	1.0	1.0	1.0
Nutrition	**0.9**	**0.9**	**0.9**	**0.9**
Physical environment	1.0	1.0	1.0	1.0
AI 17: Safe and Adequate Cafeteria/Meal Service Area	1.0	1.0	1.0	1.0
AI 18: Garden Features	1.0	1.0	1.0	1.0
Situational environment	*0.9*	*0.9*	*1.0*	*1.0*
AI 19: School Meals	1.0	1.0	1.0	1.0
AI 20: Promoting Healthy Food and Beverage Habits	1.0	0.8	0.8	1.0
AI 21: Healthy Food and Beverage Practices	1.0	1.0	1.0	1.0
AI 22: Promoting Water Consumption	0.8	0.8	1.0	0.8
AI 23: Cafeteria Atmosphere/Ambiance	0.8	1.0	1.0	1.0
AI 24: Before/After School and Summer Extracurricular	0.8	1.0	1.0	1.0
Policy environment	*0.9*	*0.9*	*0.9*	*0.9*
AI 25: Nutrition and Wellness Policy	0.8	1.0	1.0	1.0
AI 26: Nutrition and Wellness Committee	1.0	0.8	0.8	0.8
AI 27: Health and Nutrition Education	1	0.8	0.8	0.8
OVERALL *(S-CVI/Ave)*	**0.96**	**0.96**	**0.98**	**0.96**

Pilot testing

Table 6 presents the results of the SPAN-ET-ES pilot testing phase for five Spanish schools located at Santa Coloma de Gramenet. Following the field-work SPAN-ET-ES guidelines, the two trained auditors collected the documentation needed to assess the 27 AI for each school. Furthermore, they were asked to collect extra information about the availability of each suggested information source for primary and secondary data collection. That is, auditors reviewed whether the informant category, documentation and other required data sources were available in each school as expected. In all cases, they confirmed the existence of each data source as well as its accessibility. Besides small changes for the field-work guidelines, we can conclude that SPAN-ET-ES is based on information that is available in the Spanish context, which allow a proper assessment for each AI. Auditors also indicated that the items included in the different AI were easily understood. On average, collecting all the required information for SPAN-ET-ES took around 15 hours per school: (i) 5 hours reviewing documentation and preparing the school visit; (ii) 4 hours performing individual interviews; (iii) 3 hours for school visit; and, (iv) 3 hours for the final agreement and writing the final report.

In overall, we found a high agreement between the two auditors when evaluating each AI. We only found two main disagreements in AI 1 and 23 which were easily solved after reviewing complementary data sources. Once the total evaluation was performed, we gave a comprehensive feedback and recommendation report, in which we provided a clear and practical list of opportunities for improvements in each AI as well as easy-access resources that allow schools to implement each recommendation. These reports were delivered during an individual meeting with each school in which results were presented. Table 6 presents the results of the assessment after applying SPAN-ET-ES in the pilot testing sample.

Table 6. Level of accomplishing of each item and area of interest after applying SPAN-ET-ES in the pre-pilot sample.

	School 1	***School 2***	***School 3***	***School 4***	***School 5***
Physical activity					
Physical environment	*Fair Practice*	*Good Practice*	*Good Practice*	*Fair Practice*	*Fair Practice*
AI 1: Indoor Physical Activity Space	0/15 (0%)	13/15 (87%)	11/15 (73%)	0/15 (0%)	12/15 (80%)
AI 2: Fixed-Outdoor Features/Space	4/9 (44%)	4/9 (44%)	4/9 (44%)	3/9 (33%)	2/9 (22%)
AI 3: Shelter and Shade Structures	1/3 (33%)	0/3 (0%)	3/3 (100%)	1/3 (33%)	0/3 (00%)
AI 4: Natural Features	0/4 (0%)	0/4 (0%)	1/4 (25%)	0/4 (0%)	0/4 (00%)
AI 5: Garden Features	0/3 (0%)	0/3 (0%)	1/3 (33%)	2/3 (67%)	1/3 (33%)
AI 6: Surface and Surface Markings	2/4 (50%)	2/4 (50%)	1/4 (25%)	2/4 (50%)	1/4 (25%)
AI 7: Enclosures and Safety Features	7/7 (71%)	7/7 (100%)	7/7 (100%)	6/7 (86%)	7/7 (100%)
AI 8: Neighborhood Features	1/5 (20%)	1/5 (20%)	1/5 (20%)	1/5 (20%)	1/5 (20%)
Situational environment	*Good Practice*	*Fair Practice*	*Good Practice*	*Good Practice*	*Good Practice*
AI 9: Portable Equipment	1/6 (17%)	1/6 (17%)	2/6 (33%)	5/6 (83%)	5/6 (83%)
AI 10: Atmosphere/Ambiance	6/7 (86%)	2/7 (29%)	4/7 (57%)	2/7 (29%)	3/7 (43%)
AI 11: Promoting Movement Opportunities	2/6 (33%)	2/6 (33%)	4/6 (67%)	1/6 (17%)	3/6 (50%)
AI 12: Before/After School and Summer Extracurricular	10/12 (83%)	5/12 (42%)	11/12 (92%)	10/12 (83%)	11/12 (92%)
AI 13: Gardening	0/3 (0%)	1/3 (33%)	2/3 (67%)	1/3 (33%)	1/3 (33%)
Policy environment	*Fair Practice*	*Fair Practice*	*Fair Practice*	*Fair Practice*	*Fair Practice*
AI 14: Physical Activity and Wellness Policy	0/10 (0%)	0/10 (0%)	0/10 (0%)	0/10 (0%)	0/10 (0%)
AI 15: Physical Activity and Wellness Committee	4/5 (80%)	0/5 (0%)	4/5 (80%)	4/5 (80%)	4/5 (80%)
AI 16: Structured Physical Education	8/10 (80%)	8/10 (80%)	8/10 (80%)	8/10 (80%)	8/10 (80%)
Nutrition					
Physical environment	*Good Practice*	*Good Practice*	*Best Practice*	*Best Practice*	*Good Practice*
AI 17: Safe and Adequate Cafeteria/Meal Service Area	4/5 (80%)	5/5 (100%)	5/5 (100%)	5/5 (100%)	4/5 (80%)
AI 18: Garden Features	0/2 (0%)	0/2 (0%)	2/2 (100%)	2/2 (100%)	1/2 (50%)
Situational environment	*Good Practice*	*Fair Practice*	*Good Practice*	*Good Practice*	*Good Practice*
AI 19: School Meals	5/9 (56%)	1/9 (11%)	5/9 (56%)	5/9 (56%)	4/9 (44%)
AI 20: Promoting Healthy Food and Beverage Habits	3/7 (43%)	1/7 (14%)	3/7 (43%)	3/7 (43%)	2/7 (29%)
AI 21: Healthy Food and Beverage Practices	5/5 (100%)	2/5 (40%)	2/5 (40%)	3/5 (60%)	3/5 (60%)
AI 22: Promoting Water Consumption	5/8 (63%)	4/8 (50%)	5/8 (63%)	3/8 (38%)	6/8 (75%)
AI 23: Cafeteria Atmosphere/Ambiance	4/10 (40%)	8/10 (80%)	6/10 (60%)	9/10 (90%)	8/10 (80%)
AI 24: Before/After School and Summer Extracurricular	5/8 (63%)	0/8 (0%)	5/8 (63%)	3/8 (38%)	2/8 (25%)
Policy environment	*Poor Practice*	*Poor Practice*	*Poor Practice*	*Poor Practice*	*Poor Practice*
AI 25: Nutrition and Wellness Policy	0/15 (0%)	0/15 (0%)	0/15 (0%)	0/15 (0%)	0/15 (0%)
AI 26: Nutrition and Wellness Committee	0/5 (0%)	0/5 (0%)	0/5 (0%)	0/5 (0%)	0/5 (0%)
AI 27: Health and Nutrition Education	7/8 (88%)	4/8 (50%)	3/8 (38%)	4/8 (50%)	4/8 (50%)

Discussion

Prior work has documented the effectiveness of school based interventions for promoting nutrition and physical activity among children and adolescents (5,16). Such programs are developed within a complex school behavioral environments which in turns involves physical, situational and policy micro-environments that could facilitate or obstruct the effectiveness of any initiative to promote healthy habits among school

age population (5,6). In this setting, it is important to count with standardized tools that allow to deeply understand the complexity of the school micro-environment in its role for nutrition and physical activities. In this study, we adapted and partially validated for the Spanish context the SPAN-ET (School Physical Activity and Nutrition Environment Tool), a tool developed in the U.S. context to evaluate the school micro-environment in its different contextual dimensions.

We did not find previous experiences in the literature on cross cultural translation and adaptation to the Spanish context of tools like the SPAN-ET. In our work, apart from modifications in some criteria phrasing, the Spanish version of the SPAN-ET has incorporated important changes in some features related with specificities in legislation and cultural context. These foreseeable changes are necessary because the cross-cultural adaptation includes not only a correct translation that preserves the adequate meaning of each test item but also, if necessary, replacing items or scaling to make it relevant and valid in the new context (7,17). In particular, we added three items and deleted one. We added one item regarding the school participation in a country specific program to promote physical activity within the school (AI 12) and two more items regarding the presence of actions within the school promoting healthy habits for reducing the potential impact of new technologies on physical activity (AI 16) and nutrition (AI 27). Likewise, we deleted an item referring to the presence of a health nutrition educator as it does not exist in the Spanish education system (item H in AI 27, in the original SPAN-ET).

Face validity (the extent to which a measure reflects what it is intended to measure) was assessed through the consultation of experts at both the cross-cultural adaptation and the review stages (18). Additionally, the extensive literature and documentation review done allowed to ensure that all the significant aspects in the assessment of the nutrition

and physical activity environment were included (see section 2.2.3). The final version of SPAN-ET-ES includes more precise wording in some cases, and extensive instructions that accompanied the original SPAN-ET and that were also translated and adapted with the help of original developers.

Content validity (the extent to which a measure's items represent a proper sample of the theoretical domain of construct) (18) was studied through the collaboration of an expert committee that used content validity indexes to evaluate the comprehensiveness and representativeness of the SPAN-ET-ES content. Results obtained indicated a good relevance of the items included. Content validity facilitates interpretation of results obtained with the questionnaire and ensures construct validity.

The experience in the use of SPAN-ET-ES in a pilot study showed that it is a feasible tool in the Spanish context. One important advantage of SPAN-ET (and its Spanish version) is that it assesses simultaneously the two main school behavioral environments (e.g. nutrition and physical activity), integrates documentation, observation and interview with key school actors, and assesses multiple aspects of the physical, situational and policy environment allowing a comprehensive description of school environment. Other similar tools do not offer such a coverage and describe only some aspects of school environment (19), rely mainly in interviews with administrators (20) or includes only food or physical activity environment (21) .

This is the first study to our knowledge to offer a standardized tool to evaluate school nutrition and physical activity micro-environment in the Spanish context. Unlike other micro-environments, the school as the main driver of adoption of healthy habits has been widely under researched. Most studies considered the family food environment (FFE) as the main driver to increase the likelihood of healthy habits as it is the prime context in which children's eating behaviors emerge (3,22). There are many

mechanisms through which FFE might affect healthy habits: availability of foods in the home; accessibility to foods around the household; the role model of the parental eating behaviors; parental feeding style and parenting practices (e.g. regularity of meal times and frequency of family meals); and introducing or providing exposure to foods at early ages(23,24). Likewise, socioeconomic factors such as education levels of mothers, employment status, among others are usually associated to influence the likelihood to incorporate healthy habits for school-age children and adolescents (15).

Despite the crucial role of the FFE on the healthy habits of children, the possibility to make policy intervention in this environment is very limited (2,5,25). In this sense, the school micro-environment where children spend an important share of their time become a critical place to promote healthy habits. In a recent systematic review, Micha *et al*. (5) found that there is strong evidence on that nutritional programs such as direct provision policies, competitive food/beverage standards, school meal standards increased fruit intake and vegetable, reduced the consumption unhealthy snacks, reduced total fat intake and saturated fat intake, among others. One of the most documented intervention within the school environment is the role of the school recess on the physical activity Reilly *et al.* (26) provides a systematic review on the recess during school time. Authors conclude that this type of intervention makes a small contribution to daily moderate-to-vigorous intensity physical activity.

Even though those school based interventions have well established effect on several outcomes, there is an important lack of understanding on the actual mechanisms through which those intervention produce the changes at the individual outcomes (5). Likewise, the unintended structural effects led by a specific intervention in dimension such as school policies or situational environment it is often neglected in school environment assessments tools (6,27). In this context, SPAN-ET (and its Spanish

version) provides an valuable tool to assess school environment, which can work either as baseline of an intervention or end-line effects on outcomes related with the environment itself (6).

The evidence on school-based interventions or assessments of school microenvironment is really scarce in Spain. In the framework of the initiative of health promoting schools, boosted by various international organizations (28), some authors have assessed their implantation in a sample of schools from different regions of Spain (29,30). These assessments included some aspects of physical, policy and situational environments related with nutrition and physical activities and were made with *ad-hoc* tools that had not been previously validated. They had a generalist focus on health promotion and did not evaluate in detail the school micro-environment in the above-mentioned aspects. Additionally, some training based intervention have showed a little evidence of its actual effect on nutrition related outcomes such as obesity (31,32). In Chile, in its turn, the evidence of these interventions is also very limited (33). None of this research provides any detailed baseline or end line assessment on the actual conditions of micro-environment within the school.

Although this study has achieved to obtain a valid translation of the SPAN-ET to the Spanish context and included the assessment of some psychometric characteristics, there are some other that still remain undetermined. Further research is now in process to complete the study of criterion validity, reliability (internal consistency, stability and inter-auditor agreement) and establish the construct validity using a representative sample of Spanish schools. This research is necessary to dispose of validated tools to study adequately the influence of the school environment on student's nutrition and physical activity, and the possible interrelationships among different environments such as family or neighborhood, among others. Additional research may also examine the

extent to which the use of SPAN-ET-ES could provide new data to understand the mechanisms in which school-based interventions might lead to structural transformation within the school.

While the SPAN-ET has been translated to Spanish, our validation results are limited to the Spain setting. In order to use this tool in other Spanish-speaking context like Latin-American countries, the SPAN-ET-ES should be adapted in terms of language, legislation and another context-specific characteristic in each dimension and then correspondingly validated.

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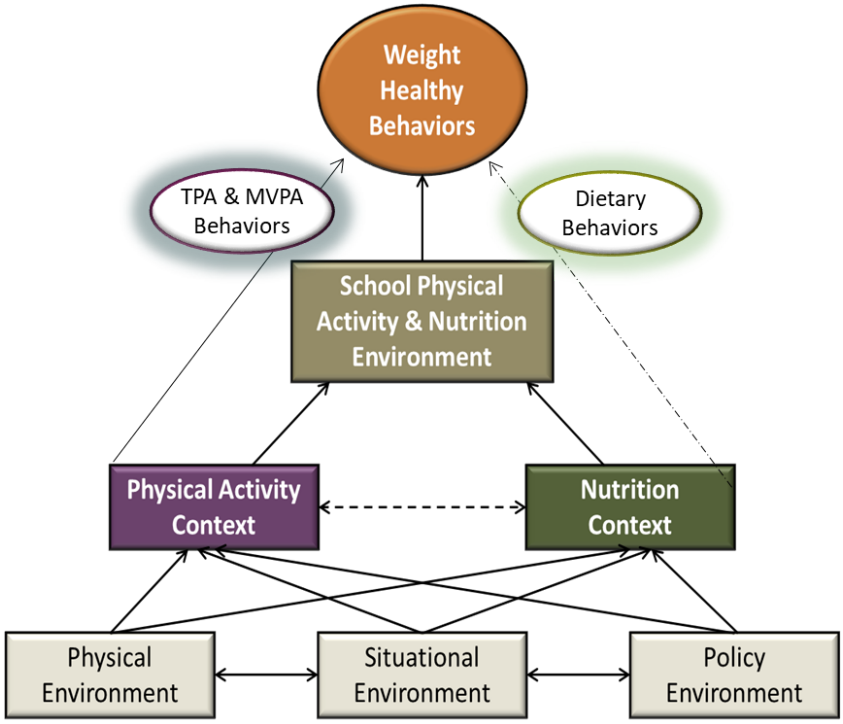
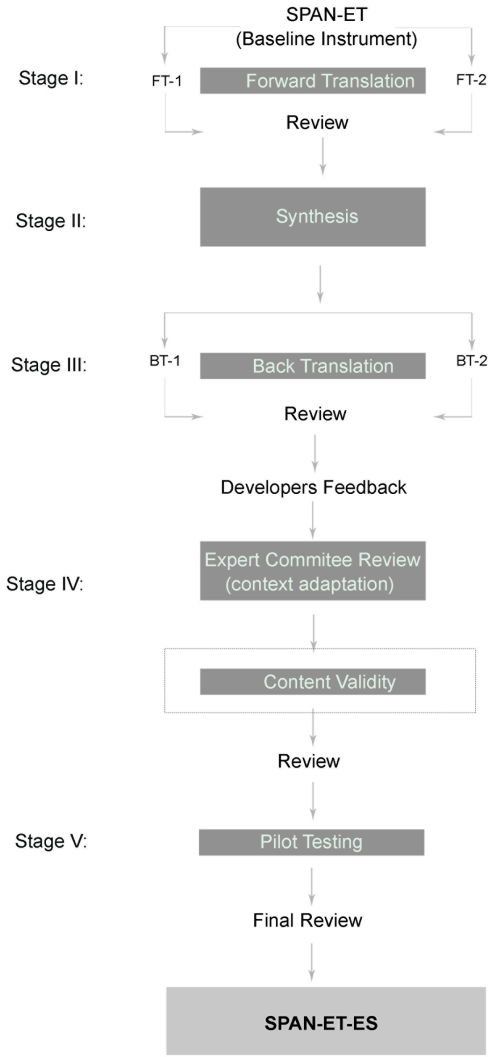
Figure legends

Figure 1. Schema explaining the multidimensional and interactive framework of the SPAN-ET.



TPA: Total Physical Activity
MVPA: Moderate to Vigorous Physical Activity

Figure 2. Global schema illustrating the different phases of cross-cultural adaptation and validation of the SPAN-ET questionnaire to the Spanish context. Stages proposed by Beaton et al. (7) for cross-cultural adaptation are indicated as *Stages I to V*. The content validity analysis through a panel of five experts was performed just before the pilot testing.



IV. DISCUSIÓN

Estudios recientes han enfatizado la necesidad de entender la formación de patrones de alimentación y hábitos de vida saludables desde un enfoque sistémico, donde se reconozcan como el resultado de una interacción compleja y dinámica de múltiples entornos de orden individual, social y comunitario que interactuaran a favor, o en contra, de la formación de esquemas comportamentales (53,60). De acuerdo con Story *et al.* (60), estos factores podrían resumirse en cuatro dimensiones: (i) macro-entornos; (ii) variables ambientales; (iii) entornos sociales ; y (iv) factores individuales. Aunque en la práctica es difícil incluir diseños multi-nivel donde se involucren los diferentes entornos (70), es importante construir marcos analíticos y descriptivos que permitan entender su dinámica y los mecanismos causales (55,59,63). Esto es particularmente necesario en la población en edad escolar, ya que a pesar que constituir un momento crítico para la formación de hábitos saludables que perduren a lo largo de la vida, existe poca evidencia sobre el papel de los diferentes entornos sobre sus patrones de alimentación y la formación de hábitos de vida (53,72–74).

Definir los factores determinantes de la adherencia a patrones de alimentación saludables en población escolar es un proceso complejo desde el punto de vista empírico y teórico (57,77–79). En este sentido, el primer capítulo buscó ofrecer evidencia empírica a partir del estudio de caso en la ciudad de Mataró (España), donde se evalúa la adherencia DM como una variable *proxy* de la prevalencia de hábitos saludables en la población escolar. En general, los resultados para la población en edad escolar de Mataró confirman la necesidad de mejorar la adherencia al patrón de DM en esta población: el 48,2% de los estudiantes de primaria y el 59,2% de los estudiantes de secundaria obtuvieron una puntuación baja o moderada en las categorías de adherencia (y por lo tanto necesitan mejorar su dieta para que la adherencia sea óptima). El análisis de regresión logística multi-variante mostró una adherencia óptima en estudiantes de primaria cuyas madres habían completado la educación superior, que no tenían distracciones a la hora del desayuno, y que regularmente hacían actividad física. Estos aspectos hacen referencia al micro-entorno del hogar. Asimismo, la disponibilidad de dinero para gastar se asoció con un menor grado de adherencia a MD.

Estos resultados son similares a las obtenidos en otros estudios previos realizados en España, donde se encontró que cerca del 46,7% y el 69,1% de los niños y jóvenes (2-24 años) respectivamente, no siguen patrón de DM óptimo (24,26). Resultados de otros países como Italia, Grecia y Turquía también ha observado un deterioro progresivo de este patrón de alimentación (24,32–34,36).

El análisis multivariante de la regresión logística brinda evidencia cuantitativa sobre los factores que están asociados a la probabilidad la adherencia óptima a la DM. El nivel de educación de la madre se asoció positivamente con el grado de adherencia. Esta observación coincide con lo encontrado en estudios similares (26,33,43,102,103) y podría deberse a que las decisiones relativas a la dieta de los niños y adolescentes siguen siendo tomadas principalmente por la madre. Las madres con un alto nivel educativo pueden influir en las decisiones que sus hijos toman mediante la disponibilidad y accesibilidad de ciertos alimentos, así como por la influencia que ejercen como modelo a seguir para ellos. También es posible que un mayor nivel de educación esté asociado con mayores ingresos y, en consecuencia, una mayor disponibilidad de alimentos saludables (102). De acuerdo con el modelo de Story *et al.* (60), estos resultados estarían asociados al papel que tiene las variables ambientales, especialmente el hogar y los factores relacionados con los entorno sociales para brindar un papel protector a los niños.

En el estudio de Serra *et al.* (26), los autores hallaron que baja adherencia a la dieta mediterránea está asociada con estratos socioeconómicos y niveles de educación bajos (nivel educativo de la madre). En ese mismo sentido, existe evidencia sobre la relación negativa entre el coste financiero y el seguimiento de DM, lo que provoca que se favorezca la dieta "occidental" (e.g. comida ultra-procesada, comida rápida, entre otros) sobretodo durante la pasada crisis financiera mundial (45). Sin embargo, los resultados del estudio de Mataró no son concluyentes sobre los efectos directos del estatus socio-económico. Esto podría deberse a la aproximación de la medida del estatus socio-económico o a la estructura socioeconómica de la población seleccionada (104). Un análisis sistemático reciente (37), mostró que la mayoría de los estudios (15 de 20) detectaron una asociación entre el estatus socioeconómico y la adherencia al DM, aunque cabe señalar que en la mayoría de los casos, el nivel educativo de los padres se utiliza como una variable *proxy*. Estos resultados dan evidencia empírica acerca del rol del *entorno de consumo* sobre la formación de patrones de alimentación.

En línea con otros estudios similares, los resultados respaldan el rol de micro-entorno del hogar (*entorno organizacional*) en los hábitos de la población en edad escolar. Por un lado, se observó que los niños de escuela primaria tenían un mayor grado de adherencia a la DM que los estudiantes de secundaria (26,105,106). Esto podría deberse al efecto supervisión ejercido mediante el control de los adultos sobre las dietas de los niños, una influencia que se pierde progresivamente a medida que un individuo crece (107–109). Por otro lado, nuestro resultados sugieren que la ausencia de

distracciones durante las comidas se asocia con un mayor grado de adherencia a la DM; estudios recientes han sugerido que comer sin distracciones (como la televisión) tiene una asociación positiva con un estilo de vida saludable y reduce el riesgo de obesidad (49,110). Es posible que la ausencia de distracciones facilite la supervisión familiar y la adopción de buenos hábitos de alimentación y que, además, se eviten los efectos negativos de la publicidad de alimentos poco saludables sobre las elecciones dietéticas de los niños y adolescentes (111).

El resultado del análisis multivariado demostró que la adherencia a la DM óptima es menor entre adolescentes y niños con disponibilidad de dinero para gastar en la escuela. Aunque la disponibilidad de dinero no es un factor de riesgo *per se,* la combinación con los entornos organizacionales y el consumo de alimentos no adecuados en el interior de la institución educativa puede convertirse en un punto crítico. La institución educativa es el lugar donde los niños, niñas y jóvenes pasan la mayor parte de su vida diaria y donde consumen entre un tercio y la mitad de sus comidas, lo que hace que este micro-entorno sea una influencia crítica para la formación de hábitos saludables (99). Asimismo, el entorno comunitario alrededor del colegio aparece como un factor de riesgo adicional para la población en edad escolar. Es común encontrar cerca de los centros de enseñanza una alta oferta de restaurantes de comida rápida, cafeterías, supermercados, lugares con máquinas expendedoras, entre otros (112). Así, el menor nivel de supervisión parental debido a la independencia progresiva de los adolescentes, así como la influencia de las diferentes variables ambientales como la oferta de alimentos junto con precios bajos para los alimentos poco saludables pueden facilitar cambios negativos en la calidad de su dieta (111–113).

Finalmente, llama la atención el poco peso de los factores individuales para explicar el grado de adherencia a la DM. Este resultado ha sido también reportado por otros estudios (37), donde variables como la edad, el sexo, el índice de masa corporal o el país de origen de los padres resultan sin diferencias significativas a nivel estadístico. No obstante, las horas de sueño parece ser un factor individual determinante que está inversamente asociado con la adherencia óptima al DM (114). En suma, aunque los resultados del estudio de la población escolar de Mataró no permiten establecer relaciones causales, ofrecen una visión descriptiva del rol de los diferentes entornos en la formación de los patrones de alimentación y hábitos de vida en la población en edad escolar. Adicionalmente, pone de manifiesto la necesidad de desarrollar nuevos instrumentos que permitan entender la interacción de los factores individuales con los demás *entornos comunitarios*, *organizacionales* y de *consumo*.

En este sentido, entre las diferentes alternativas para el estudio de *entornos comunitarios*, los métodos basados en SIG ofrecen una alternativa que pueden solucionar los desafíos tradicionales para estudiar este tipo de entornos (85,86,88,115). En el segundo y tercer capitulo se ha validado la nueva herramienta llamada *Facility List Coder* (FLC), esta herramienta permite evaluar los *entornos comunitarios* de manera automática utilizando datos secundarios de los dos motores de búsqueda geográficos más tradicionales: Google Maps y Open Street Maps. La validación se realizó usando el caso de Mataró (España), mediante la comparación de la clasificación automática de los elementos del entorno comunitario proporcionada por el FLC con la visita física de una muestra representativa de calles. Los resultados indican que el FLC tiene una alta fiabilidad con respecto a las visitas físicas.

El FLC cumple con las propiedades que según Wilkins *et al.* (116) debe tener de manera explícita este tipo de herramientas para garantizar su pertinencia en la evaluación entornos comunitarios. En primer lugar, el FLC hace una búsqueda espacial en una amplia base de datos que es administrada de forma centralizada por cada empresa, pero a menudo son actualizadas por los usuarios (*food outlet data*). En segundo lugar, una vez se realiza la consulta es posible tener un inventario completo de los establecimientos presentes en el área de interés (*extracting food outlets*). En tercer lugar, una vez obtenida la lista completa de instalaciones, cada instalación (por ejemplo, tienda. supermercados, bar, panadería, etc.) se filtra y clasifica automáticamente utilizando los metadatos disponibles según un conjunto de palabras clave multilingüe predefinidos (catalán, español e inglés). Este conjunto de palabras clave se estableció por primera vez utilizando la lista completa de tipos de puntos de venta desarrollados por la Generalitat de Cataluña (España), el cual provee 10 diferentes tipos de establecimiento comerciales presentes en los contextos europeos (117). Esta clasificación inicial es agregada con el fin de ser comparable con otros estudios internacionales (118), en cuatro categorías: (i) restaurantes de comida rápida, (ii) bares/restaurantes, (iii) supermercados y (iv) tiendas de conveniencia y otros (*defining food outlet constructs)*. Finalmente, en cuarto lugar, dado que la información incluye la localización (*geocoding methods*), FLC proporciona diferentes mediciones de distancias como la distancia de red, la distancia a pie, entre otros (*access metrics*).

En la literatura, existe una preocupación sobre el nivel de confianza y precisión que ofrecen los métodos que se basan en los datos secundarios para medir los entornos alimentarios comunitarios (86,116,119). A menudo, los investigadores parte de censos o listas de establecimientos comerciales como fuente principal de datos. Estos datos se recopilan principalmente con fines oficiales o

comerciales y a menudo presentan varias limitaciones relacionadas con la ubicación geográfica y la actualización, lo que conduce a una alta heterogeneidad en la calidad de los datos entre diferentes fuentes. Mendez *et al.* (120), después de comparar dos censos de establecimiento comerciales para Estados Unidos, encontró que los resultados sobre la asociación entre medidas de salud y establecimientos comerciales es altamente sensible a la elección de la fuente de información. Este problema empírico se debe principalmente a la gran diferencia entre las dos fuentes de datos usadas en el estudio y señala la importancia de la validación de las fuentes de información antes de usarlas. Generalmente, esta validación se realiza a partir de comparar la información secundara con la verificación en campo por parte de los investigadores (116,121). Con este enfoque, Wilkins *et al.* (121) validaron las dos principales censos de establecimiento comerciales para el Reino Unidos. Los autores concluyeron que estos dos conjuntos de datos secundarios proporcionaban una buena vista del estado real de los entornos alimentarios. Sin embargo, la posibilidad de generar una validación de datos secundarios a partir de una visita física no siempre posible por restricciones de tiempo o presupuesto. En estos casos, dado los resultados de fiabilidad y validez, el FLC podría usarse como fuente de datos principal o fuente de validación para el estudio de entornos comunitarios.

Siguiendo el modelo sistémico de Story *et al.* (60), los *entornos comunitarios* estarán en una constante interacción con otras variables ambientales como las dimensiones socio-demográficas (84). Estudios recientes sugieren que las familias de bajos ingresos son más propensas a verse afectadas por el entorno alimentario circundante (86,122). Por lo tanto, tener medidas validadas y estandarizadas de los entornos alimentarios en estos contextos puede ser difícil, constituyendo un desafío empírico ya que en ocasiones los datos administrativos son de baja calidad o simplemente inexistentes. Otras veces, los datos existen pero su acceso no es público. En todos estos casos, el FLC puede ser utilizado como la principal fuente de información para identificar entornos de alimentación comunitarios en los casos en que los investigadores u profesionales tengan un presupuesto limitado, o en áreas de estudio donde se imposible utilizar otras técnicas intensivas, como un censo de instalaciones. Además, a pesar de que la calidad de la información en los motores de búsqueda geográficos puede variar según el país, la alta cobertura espacial hace que el FLC pueda ofrecer estimaciones de entorno alimentario en lugares donde otras fuentes de información no existen o no están disponibles para los investigadores. Sin embargo, antes de aplicar el FLC es importante asegurarse de la calidad de la información de los datos disponible en los motores de búsqueda geográfico, especialmente en el caso de los países en vías de desarrollo.

El FLC presenta algunas limitaciones que deben ser tenidas en cuenta. Dado que el FLC se basa en información secundaria, puede existir la probabilidad de un sesgo de medición ya que estas fuentes de información combinan información centralizada con otra auto-reportada por usuarios (116). No obstante, independiente de su origen, la información disponible en estas fuentes de información es verificada y estandarizada para garantizar un buen control de calidad (123,124). El hecho de que alguna información sea auto-reportada por usuarios podría dar lugar a las siguientes limitaciones: (i) el FLC podría subestimar el entorno alimentario en lugares con una baja cobertura de la información y (ii) el FLC podría asignar erróneamente las instalaciones en lugares donde no se dispone de más información. Aunque es imposible descartar estos sesgos por completo, otros investigadores (125) han evidenciado la validez y buena calidad de esta información. Los resultados de nuestro estudio de validación confirman esta calidad.

Otra preocupación potencial está asociada a proceso de clasificación automática de los establecimientos con oferta alimentaria. Lake *et al.* (118) realizan una revisión de la literatura donde se plantean los requerimientos y retos para desarrollar clasificaciones de entornos alimentarios. Los autores concluyen que no es posible proporcionar una sola clasificación que pueda aplicarse en cualquier contexto. Por lo tanto, siguiendo las recomendaciones de los autores, el FLC presenta una clasificación simple, conservadora y de comparabilidad internacional lo cual ofrece la oportunidad para hacer análisis de línea base y presenta una posibilidad interesante para futuros proyectos de investigación a gran escala con tratamiento de *big data* (121).

El FLC no es la única herramienta basada en SIG para la evaluación de entornos comunitarios. El SPOTLIGHT (S-VAT) utiliza las vistas de la calle proporcionadas por Google Earth para desarrollar una evaluación de entornos alimentarios comunitarios visitando virtualmente los sitios de interés (123,126). Junto con las imágenes de Google Earth, los investigadores proveen un instrumento predefinido para describir cada detalle que se encuentra durante la visita virtual. Como resultado, basándose exclusivamente en las fachadas y otras características físicas, se crea una lista de los establecimientos comerciales, características de accesibilidad, infraestructura, transporte público, entre otros. Bethlehem *et al.* (123) encontraron que el S-VAT era una herramienta confiable para clasificar los entornos alimentarios en Europa.

El FLC difiere del S-VAT en diversos aspectos. En primer lugar, el FLC se centra en determinar las características de cada entorno alimentario mediante la revisión de toda la información disponible de cada establecimiento (por ejemplo, tipo, imágenes, horarios de apertura, comentarios

de clientes, entre otros). Por su parte el S-VAT sólo se basa en la imagen de las fachadas lo que puede dar lugar a importantes clasificaciones erróneas (por ejemplo, establecimiento cerrados). En segundo lugar, a diferencia del S-VAT, los resultados de FLC proporcionan un barrido completo de todas las instalaciones las cuales son clasificadas de manera automática, lo cual reduce su demanda en tiempo y costo. En tercer lugar, dado que el S-VAT se basa en la auditoría visual de cada calle, es más difícil recopilar metadatos o características de cada instalación. Por lo tanto, el FLC y el S-VAT son herramientas diferentes que se complementan entre sí.

Los resultados de validación del FLC permiten concluir que es una nueva herramienta adecuada para estudiar el *entorno comunitario.* No obstante, el FLC no ofrece ninguna información sobre los entornos de consumo y organizacionales dentro de las instituciones educativas. Este micro-entorno está compuesto por aspectos físicos, situacionales y de política que podrían facilitar u obstruir intervenciones dirigidas a promover hábitos saludables entre la población en edad escolar (74,127). Por tal motivo es importante contar con herramientas estandarizadas que permitan comprender las dinámicas y complejidades del micro-entorno escolar y su papel en la formación de patrones alimentarios y hábitos de vida saludables. En el capítulo cuarto, se ha realizado la adaptación transcultural y validación de contenido del *SPAN-ET (School Physical Activity and Nutrition Environment Tool*), una herramienta desarrollada en Estados Unidos para evaluar el micro-entorno escolar en sus diferentes dimensiones contextuales.

El nuevo SPAN-ET para España, o SPAN-ET-ES, es la primera herramienta para evaluar específicamente el micro-entorno escolar incluyendo la idiosincrasia y marco jurídico del sistema español. El SPAN-ET-ES ha incorporado importantes cambios en algunas características relacionadas con especificidades en la legislación y el contexto cultural. Estos cambios fueron necesarios ya que la adaptación transcultural va más allá que la mera traducción del lenguaje, haciendo necesario la inclusión o eliminación de ítems de valoración del entorno que sean relevantes y válidos en el nuevo contexto (128,129). En el caso del presente estudio se añadieron tres elementos y eliminamos uno. Se añadió un ítem relacionado con la participación escolar en programas estatales o locales para promover la actividad física dentro de la escuela (AI 12) y dos más con respecto a la presencia de acciones dentro de la escuela para promover hábitos saludables encaminados a reducir el impacto potencial de las nuevas tecnologías en la actividad física (AI 16) y la nutrición (AI 27). Del mismo modo, se eliminó un elemento que se refiere a la presencia de un educador en nutrición sanitaria, ya que no existe en el sistema educativo español (punto H en AI 27, en el SPAN-ET original).

El proceso de adaptación y validación de contenido se realizó mediante la participación de un panel de expertos que garantizo la aplicabilidad y pertinencia del instrumento (83). Estas opiniones de expertos se complementaron con una revisión de la literatura y la documentación que permitió la inclusión de todos los aspectos significativos en la evaluación del entorno de nutrición y actividad física en el contexto español (véase la sección 2.2.3, capitulo 4). Así, la versión final de SPAN-ET-ES incluye una redacción más precisa en algunos casos, e instrucciones extensas que acompañaron al SPAN-ET original y que también fueron traducidas y adaptadas con la ayuda de desarrolladores originales.

Finalmente, la experiencia del uso de SPAN-ET-ES durante el estudio piloto demostró su factibilidad en el contexto español. Una ventaja importante de SPAN-ET (y su versión en español) es la posibilidad de evaluar simultáneamente las dos principales dimensiones de comportamiento escolar (nutrición y actividad física). Además, integra la documentación, la observación y la entrevista con actores escolares clave, y evalúa múltiples aspectos del entorno físico, el situacional y el político permitiendo una descripción integral del entorno escolar. Otras herramientas similares no ofrecen tal cobertura y describen sólo algunos aspectos del entorno escolar (130), dependen principalmente de entrevistas con administradores (77) o incluye sólo el entorno de alimentación o actividad física (131).

El *entorno organizacional* que ha recibido mayor atención en la literatura es el entorno alimentario familiar (FFE, por sus siglas en inglés) (57,76). Existen diversos mecanismos a través de los cuales el FFE puede modificar los hábitos saludables: (i) la disponibilidad de alimentos dentro hogar; (ii) accesibilidad a los alimentos alrededor del hogar; (ii) el modelo a seguir de los comportamientos alimentarios de los padres; el estilo de alimentación de los padres y prácticas de crianza (por ejemplo, regularidad de las comidas y frecuencia de las comidas familiares); e, (iii) introducir o proporcionar exposición a alimentos a edades, entre otros (96,132). Asimismo, factores socioeconómicos como el nivel educativo de las madres y su situación laboral, entre otros, suelen estar asociados a influir en la probabilidad de incorporar hábitos saludables para los niños y adolescentes en edad escolar (133).

No obstante, a pesar del papel de los FFE, la posibilidad de realizar intervenciones en este entorno es limitada (41,74,99). En este sentido, el micro-entorno escolar donde los niños pasan una parte importante de su tiempo se convierten en un lugar fundamental para promover hábitos saludables.

En una revisión sistemática reciente, Micha *et al.* (74) demuestra que existe evidencia empírica sólida que demuestra le efectividad de las intervenciones dentro de la escuela en el incremento del consumo de frutas y verduras, la reducción de consumo de aperitivos no saludables, la disminución de la ingesta total de grasas y la ingesta de grasas saturadas, entre otros.

A pesar de esta evidencia, no se conocen con claridad los mecanismos a través de los cuales dichas intervenciones producen modificaciones conductuales en la población en edad escolar (74). Del mismo modo, se desconoce los efectos no intencionados sobre las políticas escolares o el entorno situacional causados por la aplicación de dichos programas (127,134). En este sentido, SPAN-ET (y su versión en español) proporciona una valiosa herramienta para evaluar el entorno escolar, que puede funcionar ya sea como base de una intervención o para la evaluación de efectos finales (127).

En el caso de España, existe poca evidencia sobre los efectos de las intervenciones o evaluaciones dentro de los micro-entornos escolares. Algunos autores han evaluado la implantación de una iniciativa de promoción de la salud en las escuelas impulsada por diversas organizaciones internacionales (135–137). Estas evaluaciones incluyeron aspectos de los entornos físicos, políticos y situacionales relacionados con la nutrición y las actividades físicas a través de una herramienta *ad hoc* que fue validada previamente. Sin embargo, no se evaluó en detalle el micro-entorno escolar en los aspectos antes mencionados. En otros casos, algunas intervenciones en los entornos escolares basado en actividades educativas de apoyo dentro del programa escolar sobre estilos de vida saludable por parte de profesionales han mostrado una efecto limitado en indicadores objetivos como la obesidad (138,139). Ninguna de estas investigaciones proporciona evaluación detallada de la línea de base o el punto final sobre las condiciones reales del entorno dentro de la escuela.

Aunque los resultados permiten tener una traducción adecuada del SPAN-ET al contexto español y una validación de las principales características psicométricas, en la actualidad se están llevando análisis adicionales para completar su validación y mejorar su aplicabilidad y pertinencia. Esta investigación es necesaria para disponer de herramientas validadas para estudiar adecuadamente la influencia del entorno escolar en la nutrición y la actividad física. Investigaciones adicionales también pueden examinar hasta qué punto el uso de SPAN-ET-ES podría proporcionar nuevos datos para comprender los mecanismos en los que las intervenciones escolares podrían conducir a la transformación estructural dentro de la escuela. Aunque el SPAN-ET ha sido traducido al idioma español, nuestros resultados de validación se limitan al ámbito de España. Para poder

utilizar esta herramienta en otros contextos de habla hispana como los países latinoamericanos, SPAN-ET-ES debe ser adaptado en términos de lenguaje, legislación y otra característica específica del contexto en cada dimensión y luego validado correspondientemente.

Las herramientas FLC y SPAN-ET-ES ofrecen nuevas metodológicas para el estudio del entorno comunitario y el micro-entorno escolar. No obstante, esta agenda de investigación debe complementarse con futuras investigaciones y desarrollos teóricos y metodológicos que amplíen las herramientas disponibles las cuales permitan la compresión de la formación de patrones de alimentación y hábitos de vida en niños y jóvenes. Existen tres áreas en las cuales futuros estudios podrían contribuir.

En primer lugar, es necesario desarrollar nuevos estudios de recolección primaria de información que combinen de manera explícita los diferentes entornos con el fin de entender sus interacciones y dinámicas. Esto implica no solo la combinación de instrumentos y fuentes de información, sino la creación de un marco analítico que amplíe la compresión y análisis de estos nuevos enfoques multinivel. Por ejemplo, a partir de los nuevos desarrollos en analítica y *big data*, se podría construir estructuras automáticas de análisis y recolección de grandes volúmenes de datos estructurados (indicadores) y no estructurados (texto) para el análisis de los entornos alimentarios. Segundo, con el fin de mejorar los alcances y la aplicación de herramientas automáticas de clasificación de los diferentes entornos, es importante incorporar métodos de aprendizaje de máquina (*machine learning*) que combinen nuevas fuentes de información disponible (por ejemplo, motores de búsqueda GIS, imágenes satelitales, redes sociales, entre otros). De este modo, podrían generarse métodos automáticos de clasificación con mayor precisión que logren superar las principales restricciones de usar solo las fuentes de información (Google y Open Street Maps). Finalmente, es importante desarrollar y/o adaptar nuevas herramientas para estudiar la complejidad de otros micro-entornos como las instituciones de educación secundaria lo que permitirá diseñar y monitorizar intervenciones enfocadas a la población adolescente, donde la adherencia a patrones de alimentación es aún menor que en la población infantil.

V. CONCLUSIONES

Las siguientes conclusiones se derivan de los objetivos planteados y los resultados obtenidos en la presente Tesis Doctoral:

En cuanto a los factores asociados a la adherencia a patrones de alimentación saludable:

- El estudio realizado sobre adherencia a la dieta mediterránea en la población en edad escolar de la ciudad de Mataró muestra que factores como el nivel de educación de la madre, comer sin distracciones, realizar actividad física, estar cursando la educación primaria y la disponibilidad de dinero para comprar alimentos en la escuela/colegio están asociados a la probabilidad de adherencia óptima a este patrón de alimentación. Esta asociación es directa en todos los casos, excepto en el último que es inversa). Aunque estos resultados no pueden ser generalizados a otras poblaciones, se encuentran en línea con la evidencia científica disponible.

- Los resultados obtenidos en nuestro estudio y la literatura existente sugieren que la implementación de intervenciones encaminadas a la promoción de hábitos saludables como sería la adherencia a la dieta mediterránea debería incluir la participación de los padres, especialmente aquellos con bajos niveles de educación.

- Los resultados resaltan la influencia de la disponibilidad de dinero en la disminución de la probabilidad de tener una adherencia óptima a la dieta mediterránea, lo cual puede apuntar a que el entorno de alimentación comunitario puede influir en el éxito de las intervenciones en la población de edad escolar.

Con respecto al estudio de los entornos de alimentación

- Se ha desarrollado una herramienta denominada *Facility List Coder* (FLC) de bajo costo, escalable, eficiente, fácil de usar, fiable y válida para la evaluación de entornos de alimentación comunitarios de manera automática a través de uso de información secundaria geo-referenciada.
- El FLC puede usarse como fuente primaria de datos en aquellas situaciones en las que no se disponga de fuentes de datos censales, cuando sean de baja calidad o también cuando su acceso sea demasiado costoso en relación con el presupuesto disponible. Así mismo, el

FLC puede usarse para complementar o contrastar otras fuentes de datos primarias en caso de ser necesario.

- Tras aplicar los protocolos metodológicos para la adaptación transcultural y validación de contenido del *School Physical Activity and Nutrition Environment Tool* (SPAN-ET) desarrollado en EEUU al contexto español.

- Aún no están claros los mecanismos a través de los cuales las intervenciones dentro de las instituciones educativas producen modificaciones conductuales en la población en edad escolar. Asimismo, se desconoce los efectos no intencionados sobre las políticas escolares o el entorno situacional causados por la aplicación de dichas intervenciones. En este contexto, el SPAN-ET-ES proporciona una valiosa herramienta para evaluar el micro-entorno escolar en España, que podría aplicarse como sea como línea base de una intervención o para evaluar los efectos finales de ésta.

- A pesar de que los resultados permiten tener la adaptación transcultural del SPAN-ET al contexto español y una validación de dos de las principales características psicométricas (la factibilidad y la validación de contenido), en la actualidad se están llevando análisis adicionales para completar su validación. Esta investigación es necesaria para disponer de herramientas con mayor validez para estudiar la influencia del entorno escolar en la nutrición y la actividad física de los escolares, y las posibles interrelaciones entre diferentes entornos como la familia o el entorno comunitario. Investigaciones adicionales también pueden examinar hasta qué punto el uso de SPAN-ET-ES podría proporcionar nuevos datos para comprender los mecanismos en los que las intervenciones escolares podrían conducir a la transformación estructural dentro de la escuela.

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